Annex 7: Working Documents presented to 2015 IBTSWG Meeting

WD 1 NS-IBTS species specific standard areas: Suggestion for revision to account for change in stock distribution and stock units used in the assessment

WD 2a Interpolation of missing observations needed for swept area calculation in the 1st and 3rd quarter NS-IBTS for Denmark, 2004 - 2015

WD 2b Interpolating Missing Observations required for Swept Area calculation of Marine Scotland Science (MSS) bottom trawl data 2004 – 2014.

WD 2c Interpolation of missing observations needed for swept area calculation in the 1st and 3rd quarter NS-IBTS for Norway

WD 2d Doorspread, Wingspread and Distance - French data of the IBTS 2004-2014

WD 2e Interpolating missing observations required for swept area calculation inthe 1st and 3rd quarter North Sea IBTS for Germany, 2004 – 2014.

WD 3 Gear Standardization - Net plans and gear components tables

WD 4 Intercalibration of research survey vessels:“GWEN DREZ” and “THALASSA”

WD 5 Sampling for age data: A ‘quick and dirty’ analysis on theoptions for more efficient sampling

WD 6 Analysis of Evhoe and IGFS survey data in the Celtic Sea foroptimising the sampling design

WD 7 CAMANOC Survey Report

NS-IBTS species specific standard areas: Suggestion for revision to account for change in stock distribution and stock units used in the assessment

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Stock units in assessment (WGNSSK):

1) Sprat in Division IIIa (Skagerrak – Kattegat) and 2) Sprat in Subarea IV (North Sea)

- NS-IBTS standard areas fits

3) Cod in Subarea IV (North Sea), Division VIId (Eastern Channel) and IIIa N (Skagerrak)

- NS-IBTS covers VIId only in the 1st quarter

4) Haddock in Subarea IV (North Sea), Division IIIa N (Skagerrak) and VIa (West of Scotland)

- NS-IBTS does not cover subarea VIa

5) Saithe in Subarea IV (North Sea), Division IIIa N (Skagerrak) and Subarea VI (West of Scotland and Rockall)

- NS-IBTS does not cover subarea VI

6) Whiting in Division IIIa (Skagerrak – Kattegat)

7) Whiting in Subarea IV (North Sea) and Division VIId (Eastern Channel)

- separate standard areas and indices for Subarea IV and Division IIIa ?
- NS-IBTS covers VIId only in the 1st quarter (separate index?)

11) Plaice in Subarea IV and 17) Plaice in Division IIIa (Skagerrak – Kattegat)

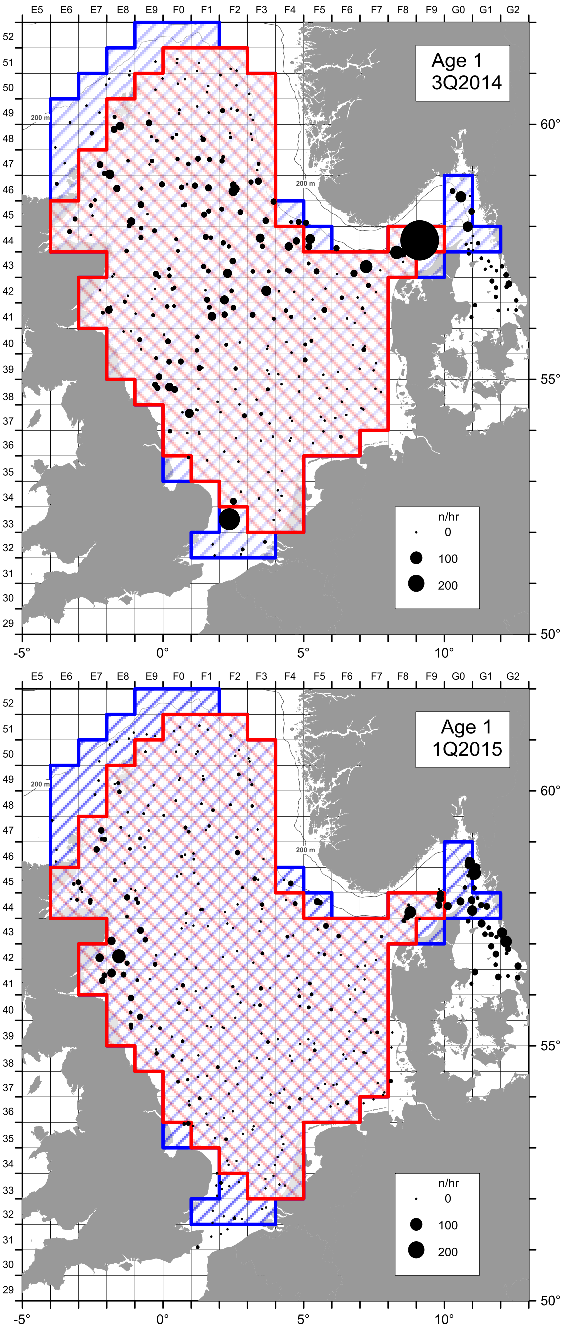
- NS-IBTS standard areas fits

16) Norway pout in Subarea IV (North Sea) and Division IIIa (Skagerrak – Kattegat)

Others:

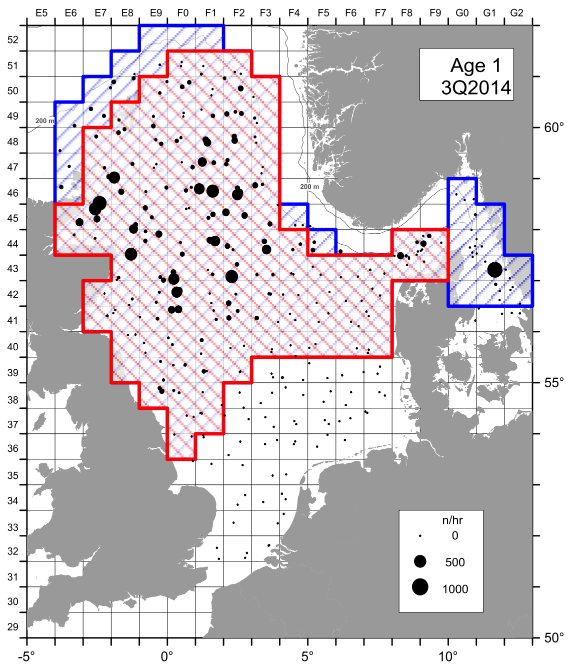
Mackerel

- NS-IBTS standard area may include entire Subarea IV and Division IIIa



Cod

Red: actual standard area, Blue: suggested extension for discussion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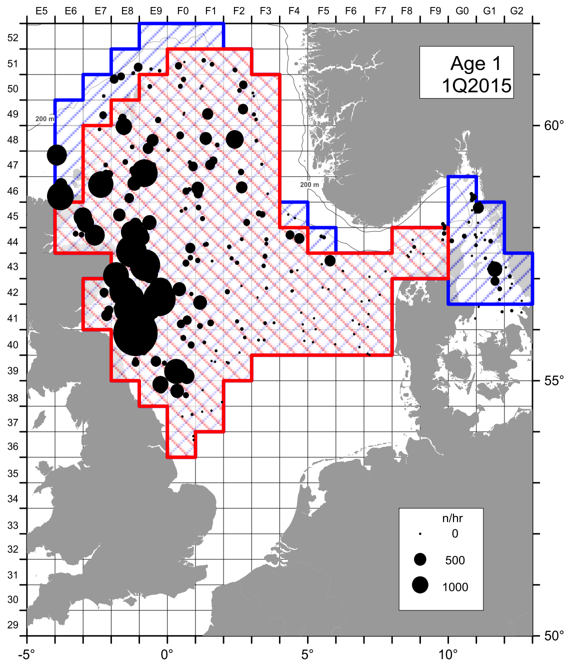
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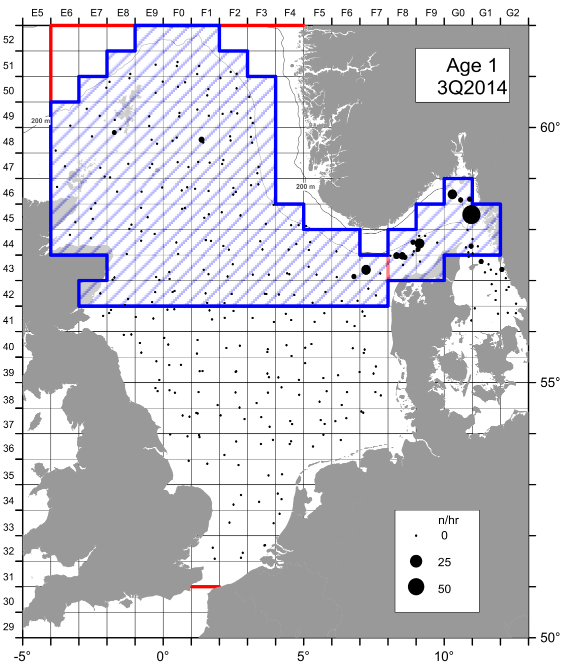
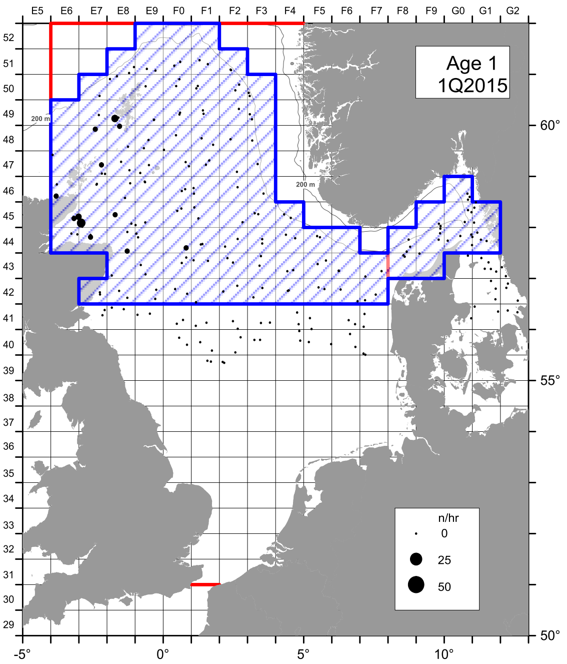
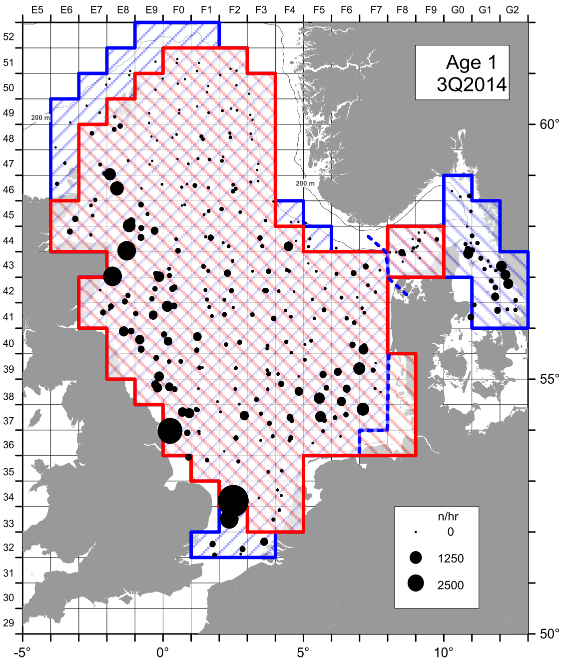
Haddock





Saithe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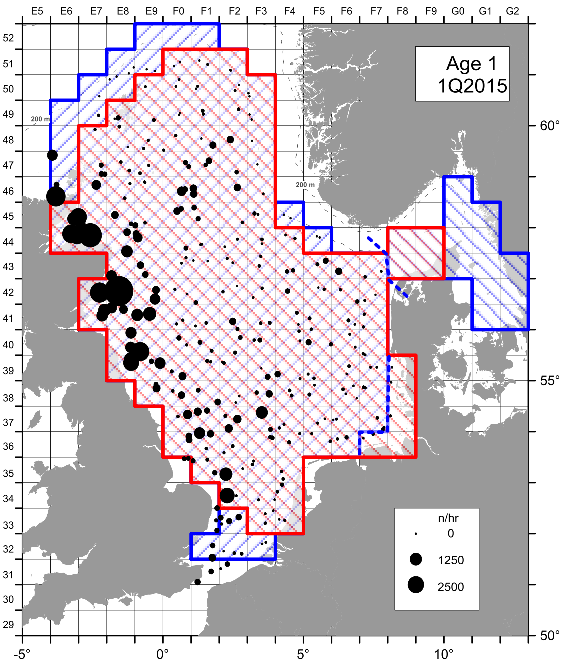
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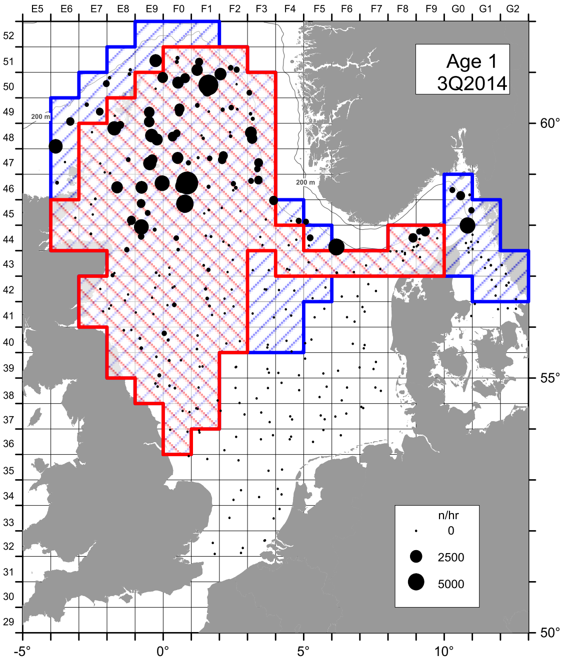
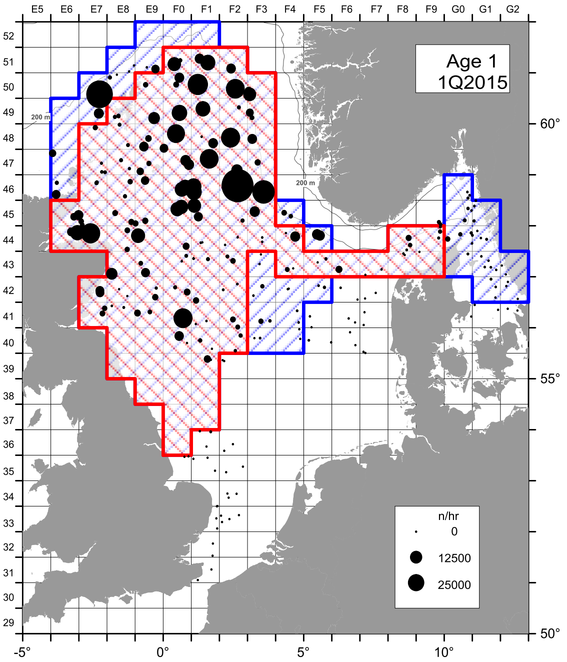
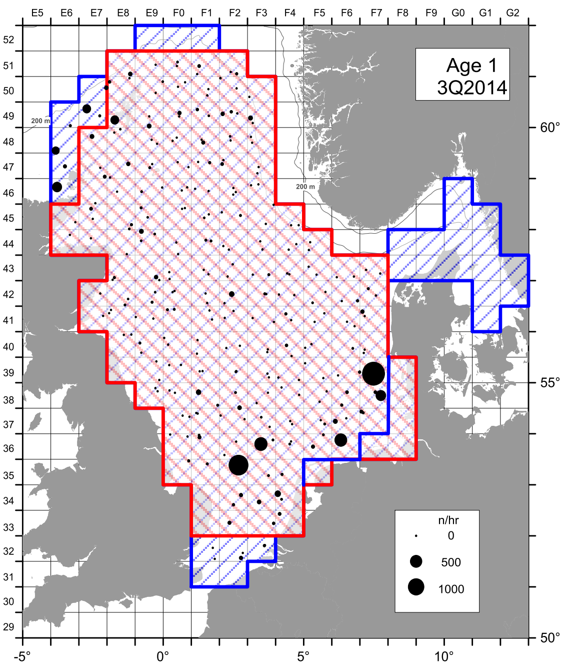
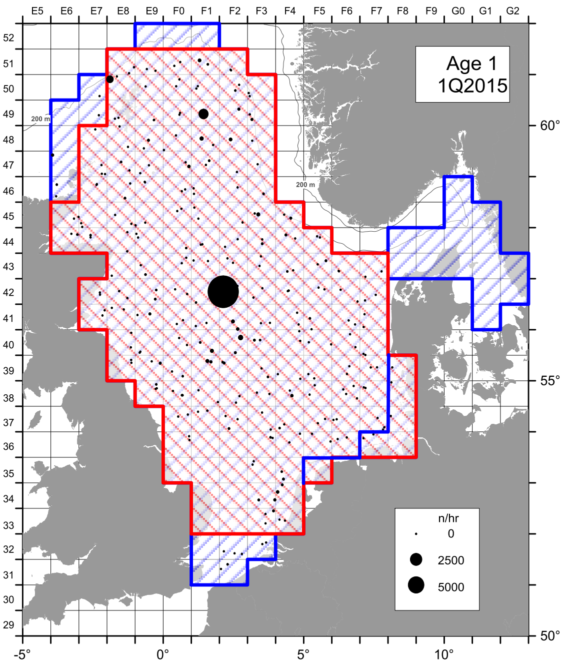
Whiting





Norway pout





Mackerel

Interpolation of missing observations needed for swept area calculation in the 1st and 3rd quarter NS-IBTS for Denmark, 2004 - 2015

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The importance of swept-area estimation has strongly emphasized by IBTSWG in 2013 following recommendations by WGISDAA (Working Group on Improving use of Survey Data for Assessment and Advice) and WKDATR (DATRAS data review priorities and checking procedures). However, several gaps and errors in the national data sets as actually stored in DATRAS were identified and all countries were asked to check and, if appropriate, to re-upload corrected data and to provide algorithms for estimating missing values needed for the calculation of swept area, i.e. towed distance, door spread (for herding species) and wing spread (for non-herding species (ICES 2013).

Denmark used the same vessel in all the years and there were also no other substantial changes in the equipment or sampling procedure over time. Hence, the observations from the entire period were combined.

Door Spread

Observations of door spread were missing in 37 cases for the short (60 m) sweeps and in 3 cases for the long (110 m) sweeps from the period 1Q 2004 to 3Q2013. The missing values can be estimated from sweep length specific depth (D) – door spread (DS) relationships based on the observations from 1Q 2004 to 1Q 2015:

$DS = 79.386 - 33.695 * EXP(- 0.028 * D)$, $r^2 = 0.379$ for the short sweeps, and

$DS = 104.502 - 316.682 * EXP(- 0.043 * D)$, $r^2 = 0.237$ for the long sweeps.

Both non-linear regressions and all coefficients for the short sweeps were highly significant but 2 out of the 3 regression coefficients for the long sweeps were not. An alternative and simpler model gave the following alternative relationships:

$DS = 25.968 + 26.331 * \log D$, $r^2 = 0.375$ for the short sweeps, and

$DS = - 2.794 + 50.953 * \log D$, $r^2 = 0.231$ for the long sweeps.

Here, both linear regressions and all coefficients were highly significant. Hence, the latter are preferable for interpolating the missing Danish observations of door spread. In contrast, the coefficients estimated in the MAFCONS project based on Scottish data between mean door spread and depth ($DS = 33.251 * \log D + 15.744$, Fraser et al. 2007) are not applicable for Denmark, in particular not for tows in which the long sweeps were used (Fig. 1).

Wing Spread

Denmark did not measure wing spread prior to the 3rd quarter 2014 and also for the 2 most recent surveys missing observations occurred for a number of stations due to technical problems or rough weather. However, the following relationships with depth for short and long sweeps were achieved from 3rd quarter 2014 and the 1st quarter 2015 survey:

$WS = 10.393 + 5.651 * \log D$, $r^2 = 0.473$ for the short sweeps, and

$WS = - 2.234 + 11.655 * \log D$, $r^2 = 0.930$ for the long sweeps.

Alternatively, wing spread could be estimated from door spread from:

$WS = 5.867 + 0.206 * DS$, $r^2 = 0.800$ for the short sweeps, and

$WS = 4.900 + 0.166 * DS$, $r^2 = 0.837$ for the long sweeps.

It appears preferable to estimate wing spread the log-relationships with depth rather than from the relationship with door spread to avoid that otherwise missing observations of door spread has to be estimated first (see above).

Again, the MAFCONS depth – wing spread relationship ($WS = 6.8515 * \log D + 5.8931$, Fraser et al. 2007) should not be used for estimating missing Danish observations of wing spread, and the two sweep lengths needs to be treated separately (Fig. 2).

Towed distance

Previously, distance had been reported as the straight distance calculated from start and end position. However, the assumption that trawling occurs along a straight line is not always true. Hence, this calculated distance has been replaced by -9 (as recommended by the IBTSWG in 2013) or replaced an observed distance from multiple GPS waypoints recorded in 1 min time intervals. So far, only the surveys back to the 1st quarter 2009 have been checked, and for this period 3 observations for observed distance based on the GPS waypoints were missing due to problems with the Ship Information System (SIS) on Dana. Tow duration, average speed over ground as well as start and end position are available in DATRAS for all stations conducted by Denmark back in time.

Correspondence between the observed distance and the calculated distance using tow duration and speed over ground was more variable than the calculated distance based on start and end position for Denmark (Fig. 2). The reason may be that tow duration and speed over ground are stored in DATRAS with no or only 1 decimal. Until observed distance has been submitted, missing observations should be calculated based on tow duration and SOG to avoid bias in cases in which the tow deviated from a straight line.

References

ICES 2013: Report of the International Bottom Trawl Survey Working Group (IBTSWG). ICES CM 2013/SSGESST:10.

Fraser, H. M., Greenstreet, S. P. R., and Piet, G. J. 2007. Taking account of catchability in groundfish survey trawls: implications for estimating demersal fish biomass. – ICES Journal of Marine Science, 64: 1800–1819.

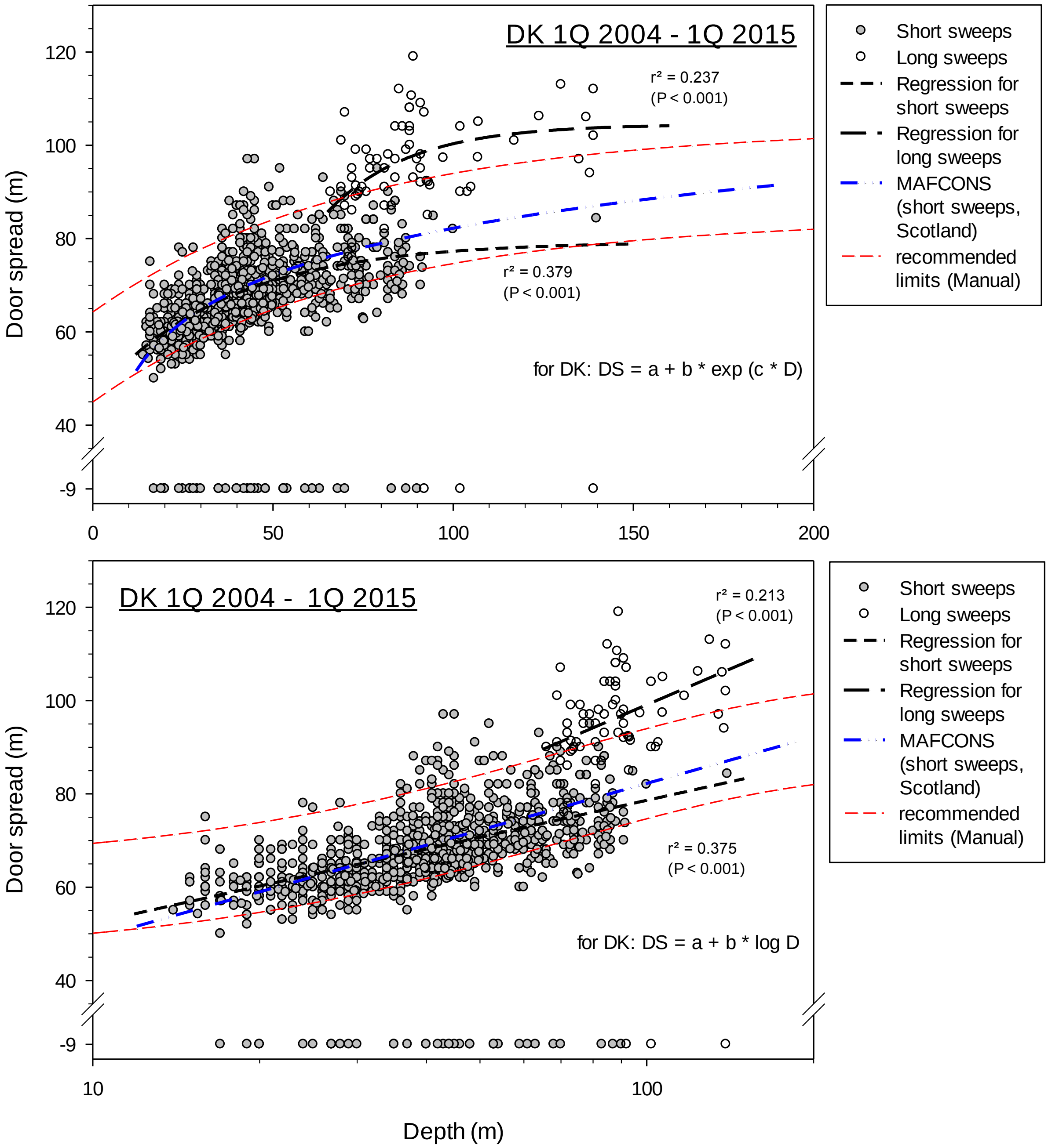

Fig. 1: Door spread – depth relationships for the Danish NS-IBTS 1st and 3rd quarter surveys since 2004 (-9 denotes missing observations; the used sweep lengths in standard tows were in accordance with the guidelines in the NS-IBTS manual, i.e. the change from 60 to 110 m sweeps at depths > 70 m in the 1st quarter surveys (prior to 2015, thereafter long sweeps used for tests only); the depth- door spread relationship established in the MAFCONS (Managing Fisheries to conserve Groundfish and Benthic Invertebrate Species Diversity) project based on Scottish data (Fraser et al. 2007) is given for comparison).

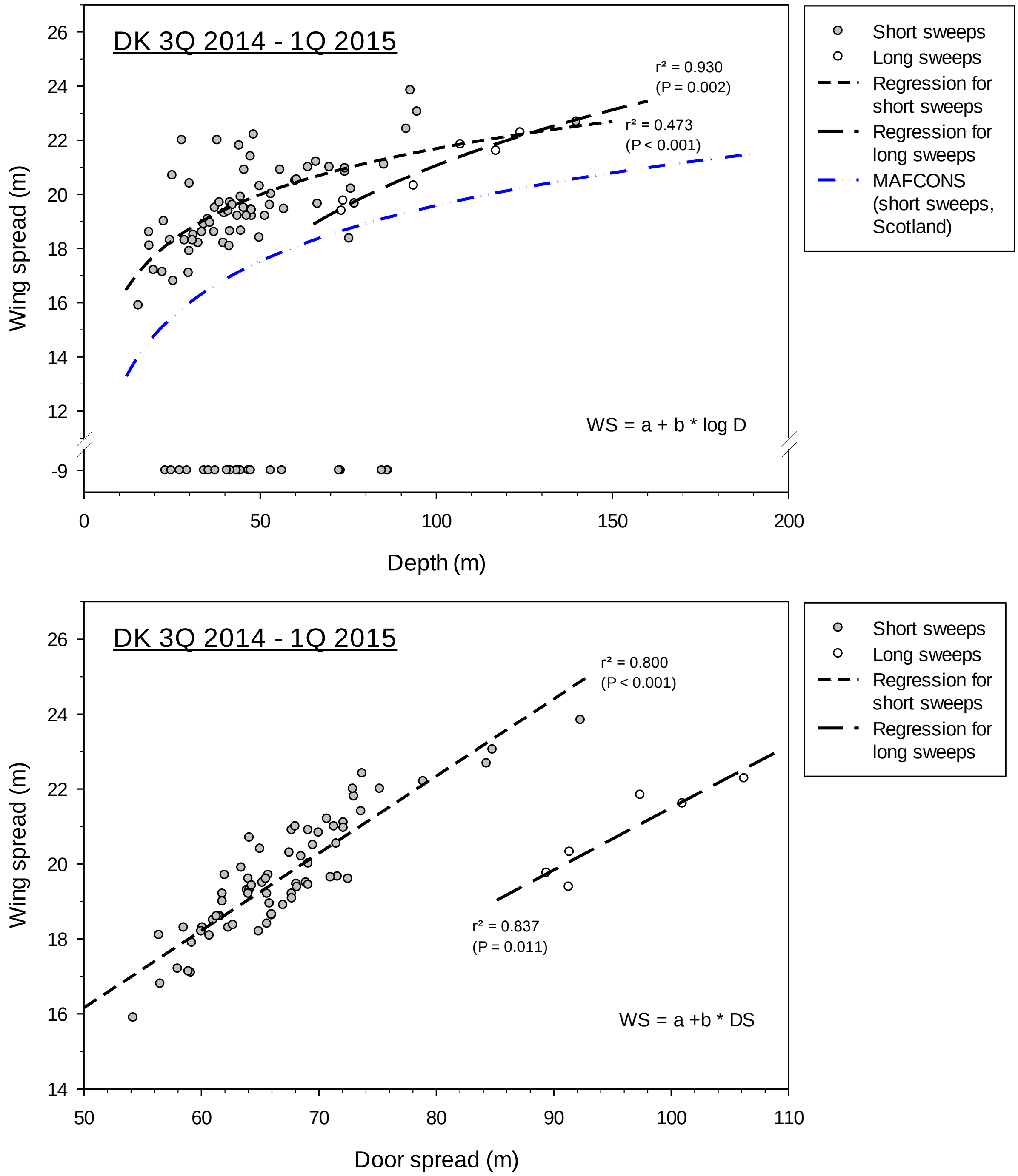

Fig. 2: Wing spread – depth and wing spread – door spread relationships for the Danish NS-IBTS in the 3rd quarter 2014 and in the 1st quarter 2015 (-9 denotes missing observations for the two surveys, long sweeps used in test tows only); the depth- wing spread relationship established in the MAFCONS (Managing Fisheries to conserve Groundfish and Benthic Invertebrate Species Diversity) project based on Scottish data (Fraser et al. 2007) is given for comparison).

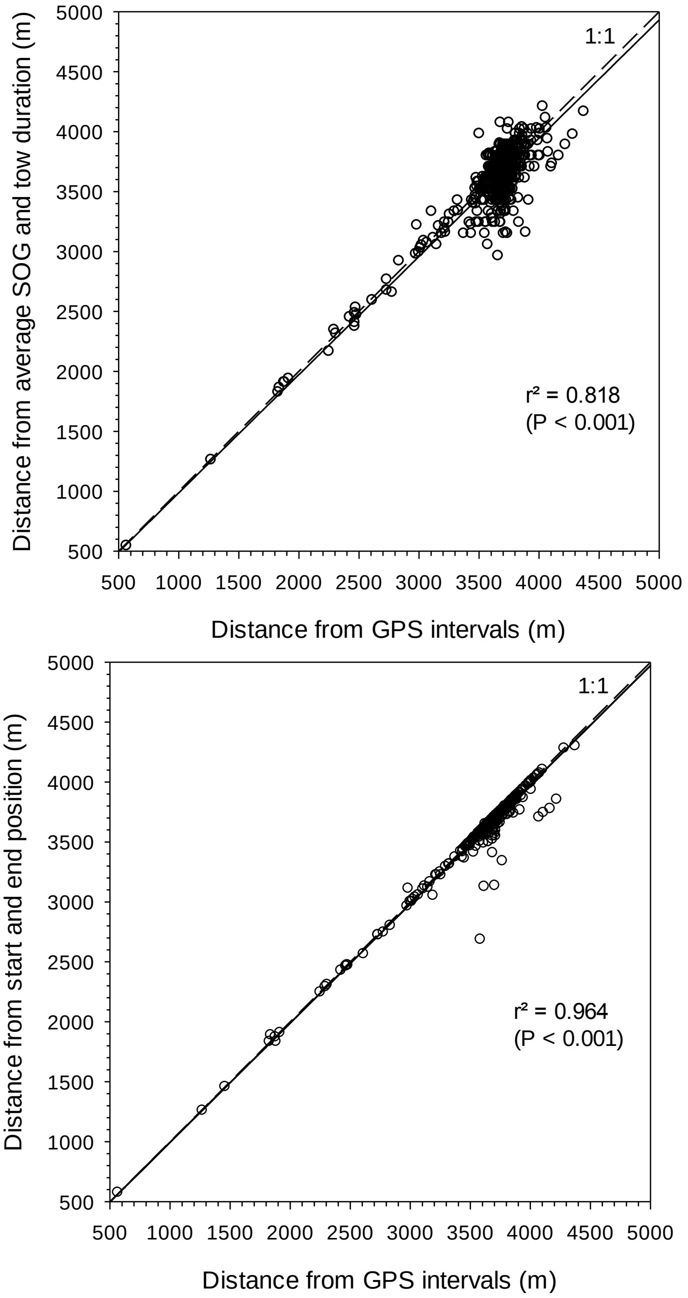

Fig. 3: Comparison of observed distance based on GPS intervals (without pitch and roll compensation) with estimated distance calculated from average speed over ground (SOG) and tow duration or distance between start and end position, Danish NS-IBTS 1st and 3rd quarter surveys since 2009 (solid lines: linear regressions, dashed lines: 1:1 identity).

Interpolating Missing Observations required for Swept Area calculation of Marine Scotland Science (MSS) bottom trawl data 2004 – 2014.

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Introduction

The importance of swept-area estimation was highlighted by IBTSWG in 2013 following recommendations by WGISDAA (Working Group on Improving use of Survey Data for Assessment and Advice) and WKDATR (DATRAS data review priorities and checking procedures). Prior to any process of swept area estimation it was necessary to review the recording and subsequent availability of those existing parameter data needed for such an estimation, namely door and wing spread and distance travelled during haul. The following working document presents the findings of such a review using MSS data from all the bottom trawl surveys uploaded to DATRAS during the agreed reference period from 2004 – 2014. By plotting the recorded parameter values and then applying a regression line to the plot an algorithm can then be used that will enable the missing value to be calculated.

All the survey series included in this review utilise the Grand Overture vertical (GOV) bottom trawl that is the standard gear used by MSS on all its multispecies bottom trawl surveys during the review period. The survey series have been separated into North Sea and West Coast/Rockall. The differences in gear configuration between these survey areas are significant with differences in groundgear used and also differences in sweep length.

Door and Wing spread

MSS have been routinely monitoring and recording door and wing spread on all their bottom trawl surveys for many years. The result being that for the given reference period of 2004 – 2014 there were only a handful of hauls where either or indeed both of these parameters were absent.

North Sea (NS-IBTS) - ICES area IV

MSS participate in both the Q1 and Q3 North Sea IBTS surveys and over the period 2004 – 2014 the gear has been standardised, with the GOV being used on both surveys with the standard (A) groundgear being utilised on all the stations south of 57’30N (ICES subarea IVb) and the more robust groundgear B being utilised on all stations north of 57’30N (ICES subarea IVa. Short (47m) sweeps are used by MSS on all stations in the North Sea surveys. Given the identical gear configuration used on these two series it was decided to aggregate all the North Sea data across quarters but then separate according to groundgear type. The rationale being that if it is assumed that different groundgears have different drag factors and that this may then result in a potentially different wing and door spread relationship.

The data from 1423 North Sea MSS hauls were plotted. 587 hauls with groundgear A and 834 hauls with groundgear B. The results, together with the linear regressions for both groundgears can be seen below in figure 1.

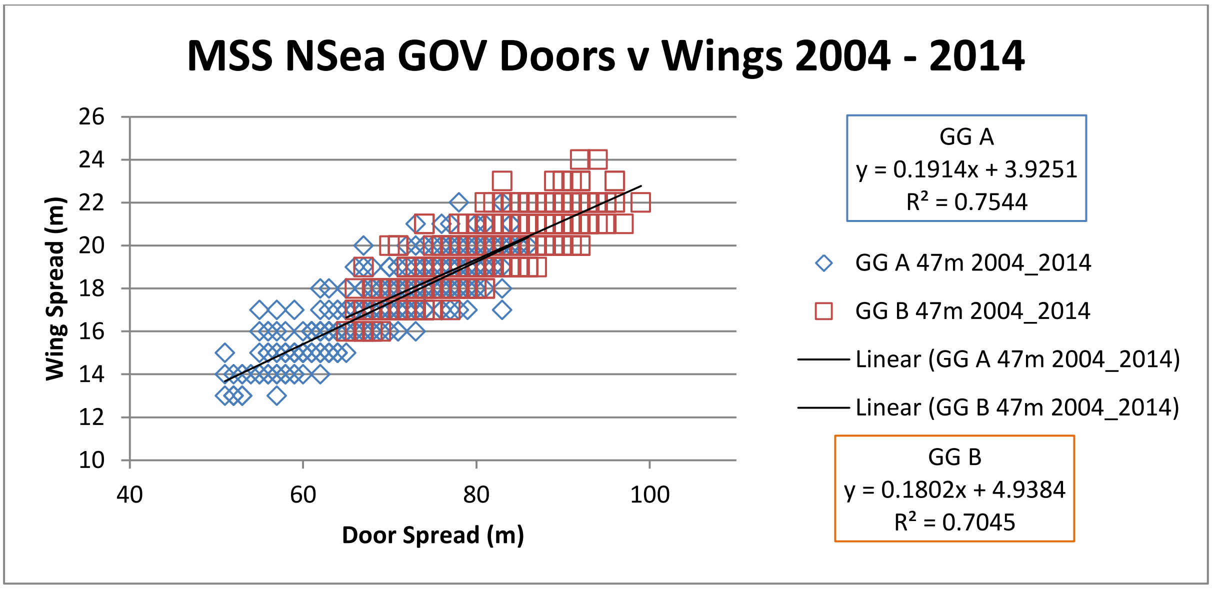


Figure 1. Door spread plotted against wing spread for MSS North Sea surveys Quarter 1 and Q3 and separated by groundgear type.

Both groundgears demonstrate the very strong relationship between door and wing spread and also meshed extremely well when plotted together. This allowed the data to be merged and enabled them to be treated as a single dataset with a single North Sea algorithm that would cover both groundgears. The resulting merged plot is displayed in figure 2 together with the linear regression and corresponding algorithm and R^2 value.

Missing Wing Spread – MSS North Sea

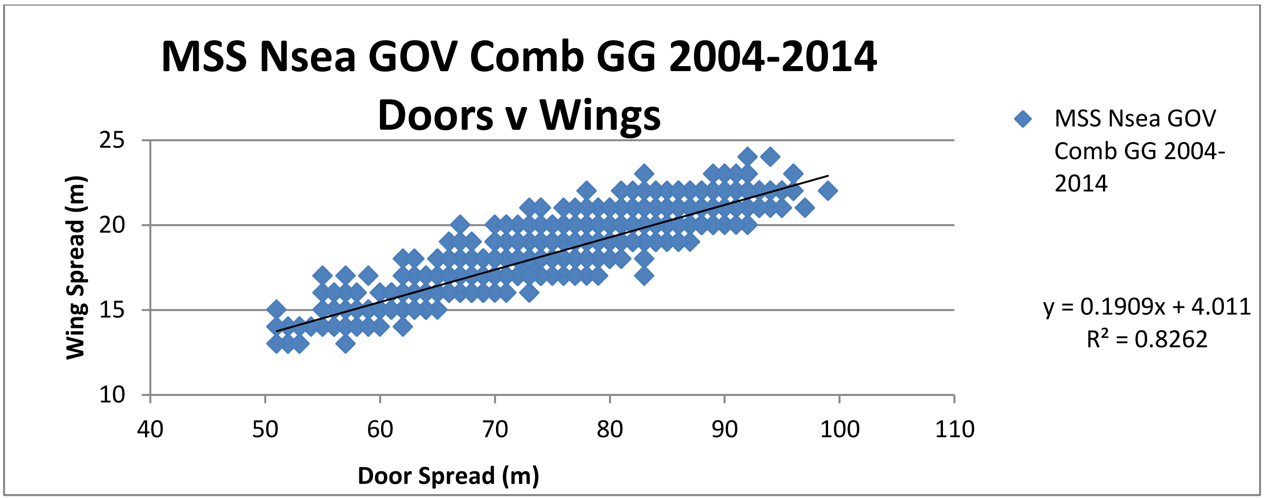


Figure 2. Door spread plotted against wing spread for MSS North Sea surveys Quarter 1 and Q3 and with groundgears combined.

The algorithm in figure 2 was subsequently applied to 11 MSS hauls in the North Sea dataset between 2004 and 2014 where wing spread was missing.

Missing Door Spread – MSS North Sea

There were 6 incidences of MSS hauls in the North Sea with no door spread and these were also derived using the same relationship but this time transposing the axis to provide the algorithm displayed in figure 3 below that allowed a derived value of door spread to be estimated.

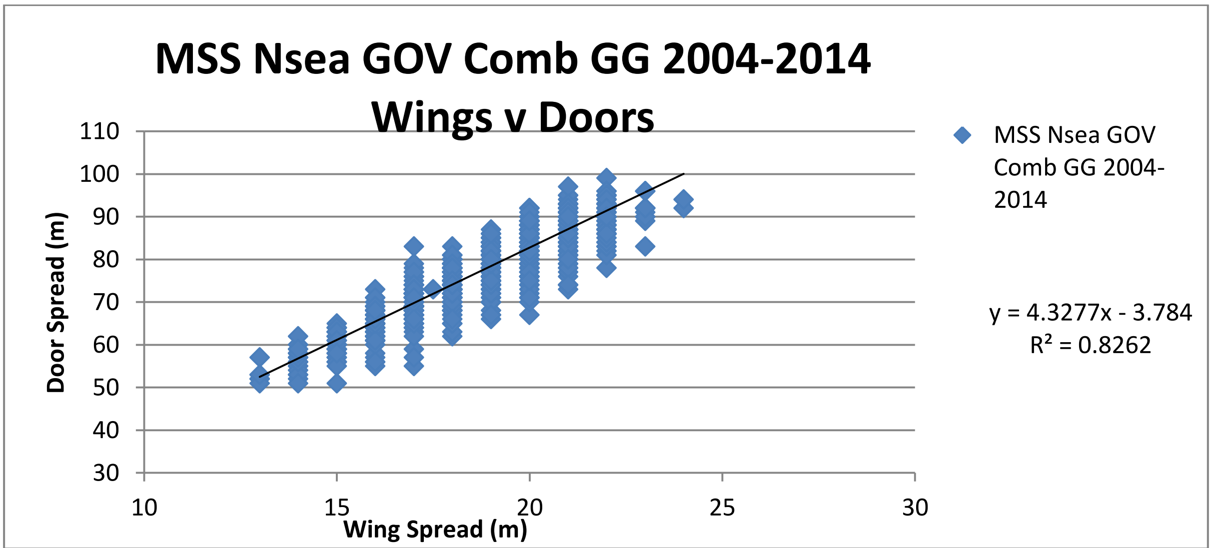


Figure 3. Wing spread plotted against door spread for MSS North Sea surveys with groundgears combined.

Missing Door and Wing Spread – MSS North Sea

There was 1 incidence of a North Sea station where there neither door or wing spread was present. To overcome this issue warp length was plotted against both wing and door spread and also demonstrated a very strong relationship (see figure 4 below). This time a non-linear logarithmic regression provided the best fit and the associated algorithms displayed were used to derive estimates of both wing and door spread.

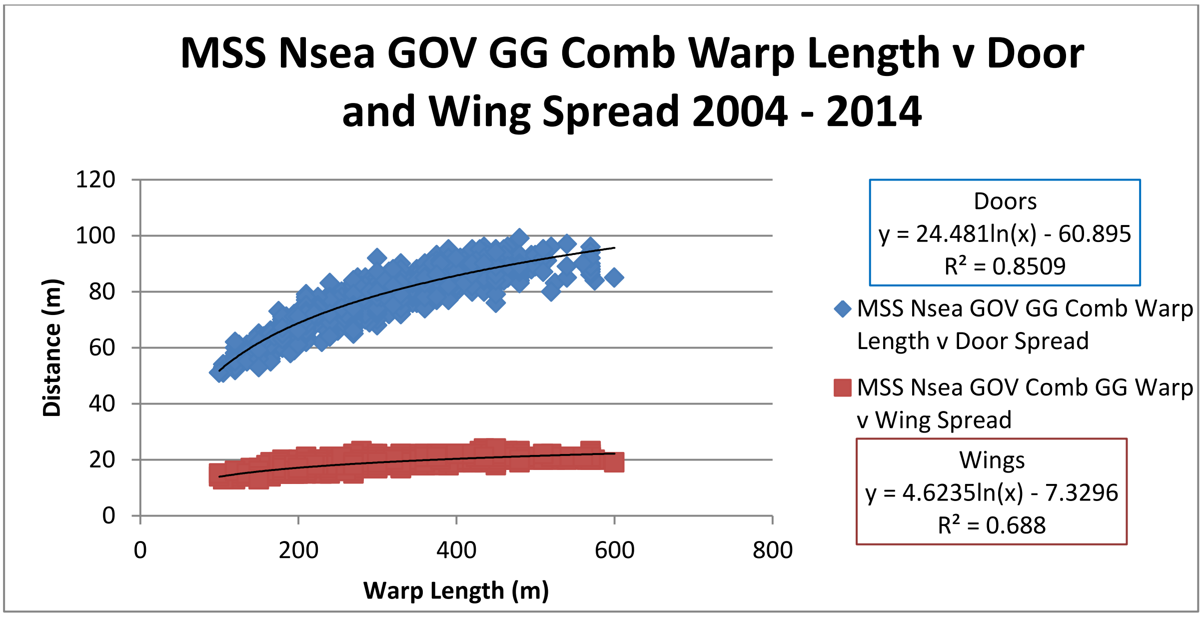


Figure 4. Door spread and wing spread plotted against warp length for MSS North Sea surveys Quarter 1 and Q3 and with groundgears combined.

West Coast (SWC-IBTS)/Rockall (ROCKALL) – ICES Area VI

MSS undertake 2 surveys in ICES Subarea VIa as well as a Rockall bank survey that is undertaken in ICES Subarea VIb. These take place during Q1 and Q4 (SWC-IBTS) and Q3 (ROCKALL) and up to an including 2010 they were undertaken using the GOV with the C groundgear. The gear configuration was consistent for all 3 surveys and also included the use of short 47m sweeps on all hauls. From 2011 onwards the west coast surveys were redesigned and transformed from a fixed/repeat station survey design to a new random/stratified survey design that utilised faunal strata and allocated effort according to the stratums variance. During this time the groundgear was also changed to mirror that already used by the Irish within area VIa, thus enhancing the comparability of both surveys. The sweep configuration was also similarly changed at this time to comply with the Irish survey with short sweeps being used on all stations where the bottom depth was less than or equal to 80m and long sweeps being used on all stations where the bottom depth was greater than 80m.

Missing Wing Spread SWC-IBTS 2004 – 2010

The Q1 and Q4 SWC-IBTS data were plotted with door spread against wing spread for years 2004 – 2010. These data had identical gear configurations as both used short (47m) sweeps as well as using groundgear C. The results of 830 hauls are plotted below in figure 5 together with the fitted linear regression and algorithm. The data are more broadly scattered than the North Sea plots previously seen and this is to be expected with a larger diversity of substrate types encountered off the west coast of Scotland coupled also with the broader depth range encountered within the survey area and the associated issues of trawling in deeper water with short sweeps.

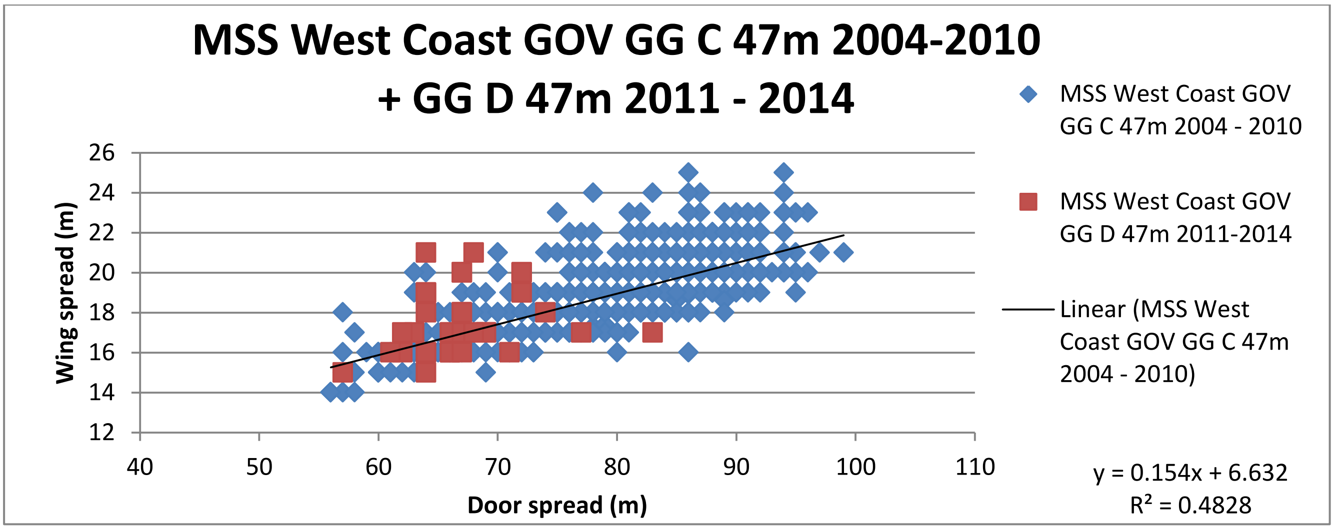


Figure 5. Door spread plotted against wing spread for MSS SWC-IBTS surveys 2004-2010 using 47m sweeps and groundgear C. 47m sweep data using groundgear D for SWC-IBTS surveys 2011 – 2014 are also overlaid for comparison.

The algorithm in figure 5 was subsequently applied to 2 MSS hauls in the SWC-IBTS dataset covering the period between 2004 and 2010 where wing spread was missing from the data uploaded to DATRAS. It should also be noted that there were no missing door spread values within any of the SWC-IBTS data over this period.

Missing Wing Spread SWC-IBTS 2011 – 2014

From 2011 the SWC-IBTS surveys utilised the GOV with groundgear D and also varying the sweep length according to the bottom depth. The majority of the hauls on these surveys are undertaken in depths greater than 80m resulting in a large amount of data being generated for the long sweeps and subsequently very much fewer data points for the short sweeps.

Figure 6 displays the plot for the long (97m) sweep data with the doors spreads plotted against wing spread. Yet again the data are very scattered resulting in a very low R^2 value when the regression line was fitted. It should be noted that this is still a young survey with relatively few hauls (340) and the hope is that the fit will improve with more data.

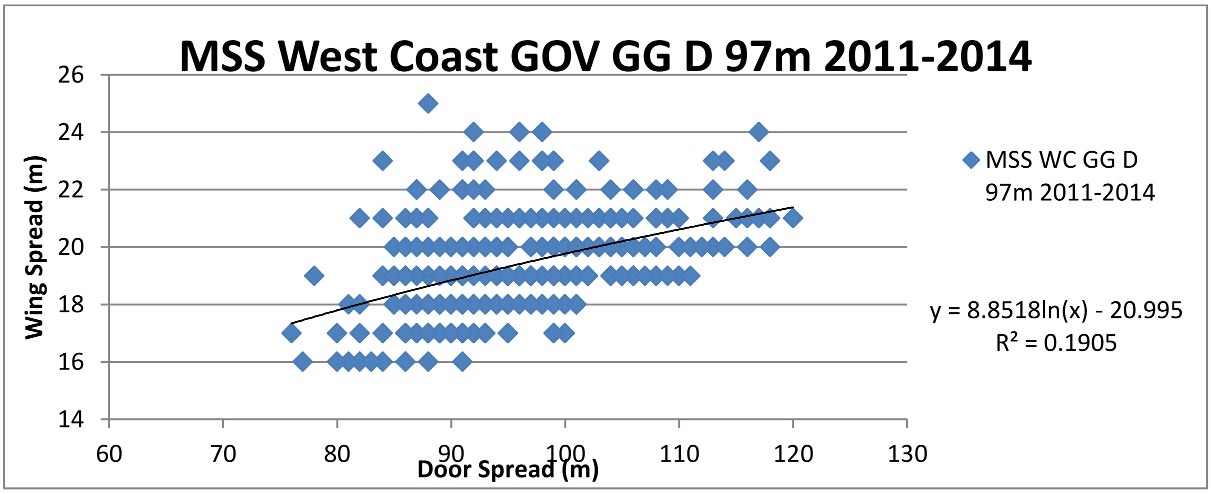


Figure 6. Door spread plotted against wing spread for MSS SWC-IBTS surveys 2011-2014 using 97m sweeps and groundgear D.

The algorithm from the non-linear regression in figure 6 was subsequently applied to 2 MSS hauls in the SWC-IBTS dataset covering the period between 2011 and 2014 where wing spread was missing from the data uploaded to DATRAS.

One haul from Q1 2014 SWC-IBTS utilising short (47m) sweeps and groundgear D was missing wing spread. Due to the sparsity of data (36 hauls) for this configuration it was decided to go with the algorithm created for the SWC-IBTS data from 2004-2010 with groundgear C and short sweeps. The groundgear D with the short sweeps data from 2011-2014 were overlaid onto the plot with the groundgear C data for comparison and appear to match up fairly well. See figure 5.

Missing Parameters – Rockall 2004-2014

No Rockall data were missing from the years 2004 – 2014. Should interpolations need to be made in the future then the algorithm applied to the SWC-IBTS groundgear D with long sweeps (figure 6) would be used as the configuration is identical to that used on the Rockall survey in Q3.

Towed Distance

MSS has traditionally measured towed distance using the point-to-point method whereby latitude and longitude are recorded from the GPS throughout the duration of the haul at predetermined regular time intervals (normally 20 seconds). These positions are then joined together and the towed distance is the calculated distance between all the positions recorded from the start and finish of the haul.

As a quality check all the MSS hauls between 2004-2014 had their distance towed recalculated using the alternative method that utilises the speed over ground (SOG) and also the haul duration.

dur/60*1852*SOG

Both estimates were compared and hauls which yielded a discrepancy greater than 10% of the total distance were investigated further. Several of the discrepancies could be attributed to incorrect SOG or typing of incorrect positions which when corrected brought the estimates back within acceptable limits. There were however several instances where this was not possible and in these instances the formula as described above was used to provide a derived estimate of towed distance. The corrected data was then reuploaded to DATRAS. A list of these hauls utilising this alternative method of distance calculation is provided below in table 1.

Country	**Survey**	**Quarter**	**Year**	**Hauls affected**	**Reason**
SCO	NS-IBTS	Q1	2005	2-82	Point recording of position was set at 5 seconds.
SCO	NS-IBTS	Q1	2013	10 - 57	Point recording of position was set at 5 seconds.
SCO	SWC-IBTS	Q1	2006	47	Unknown cause of disparity
SCO	SWC-IBTS	Q1	2013	21,64	Unknown cause of disparity
SCO	SWC-IBTS	Q1	2014	64	No distance value - GPS stopped working
SCO	SWC-IBTS	Q4	2008	48	Unknown cause of disparity
SCO	ROCKALL	Q3	2011	23	Unknown cause of disparity

Table 1. list of MSS hauls which had derived distance towed values inserted and reuploaded to DATRAS

Interpolation of missing observations needed for swept area calculation in the 1st and 3rd quarter NS-IBTS for Norway

Note: Norway uses different vessels for Q1 and Q3, so regressions have been made separately for these surveys. Norway also changed vessels, so equations have been made for only the vessels currently in use. For Q1, this is GO Sars (2009-2015) and for Q3, it is Johan Hjort (2006-2014). Data 2006-2008 are not yet cleaned/verified for the GO Sars and therefore were not used. There was a mistake made in rigging in 2011-2013 on Q3: long sweeps (110 m) + strapping were used in 2011 and 2013 for water depths >70 m, while long sweeps (110 m) + strapping were used on all tows in 2012. In 2014, door spread measurements were fairly constant with depth and with warp length, indicating that there may have been an issue with the measurements (Fig 1). Norway did not take part in the IBTS Q3 survey in 2009. Door spread equations were estimated for only the correct configuration (60 m sweep length) 2006-2013 (excluding 2009, 2012) for Q3 Johan Hjort data. Table 1 shows which data were used for the calculations.

Two equations were trialled to estimate door spread:

1) Danish formula (Wieland annex 8 IBTSWG-report 2014)
2) Door spread = depth + depth^2

There was very little difference between the 2 equations for the range of depths fished for Q1 (Fig. 2). The differences were greater on Q3 (Fig. 3).

Wing spread has not been measured on Norwegian surveys except for Q1 2015, when units were borrowed from Scotland for the first half of the survey (Fig. 4). The Norwegian GOV **does not** operate like other vessel's trawl gear; it has extremely low headline height and wider door spread (over-spreading). Because of this, no other country's wingspread estimates should be used to substitute for missing Norwegian values. Norway is working to rectify this for Q3 2015.

Door spread (DS): GO Sars 2009–2015 Q1-only

Based on depth (D), Equation 1: Danish formula:

A) For short (60m) sweeps: $DS_{60m\ sweeps} = 111.834 – 57.178 * EXP (- 0.0077 * D)$; quasi-$r^2 = 0.50$

B) For long (110m) sweeps: $DS_{110m\ sweeps} = 148.708 – 96.227 * EXP (- 0.0069 * D)$; quasi-$r^2 = 0.31$

Based on depth (D), Equation 2: depth + depth^2:

A) For short (60m) sweeps: $DS_{60m\ sweeps} = 54.84 + 0.41 * depth + -0.001 * depth^2$; $r^2 = 0.50$

B) For long (110m) sweeps: $DS_{110m\ sweeps} = 55.7 + 0.56 * depth + -0.001 * depth^2$; $r^2 = 0.30$

Door spread (DS): Johan Hjort 2006–2018, 2010-2011, 2013 Q3-only, 60 m sweeps only

Based on depth (D), Equation 1: Danish formula:

A) For short (60m) sweeps: $DS_{60m\ sweeps} = 97.793 - 45.739 * EXP (- 0.012 * D)$; quasi-$r^2 = 0.23$

Based on depth (D), Equation 2: depth + depth^2:

A) For short (60m) sweeps: $DS_{60m\ sweeps} = 64.94 + 0.152 * depth + -1.99 * depth^2$; $r^2 = 0.06$

Wing spread (WS): GO Sars 2015 Q1

Based on door spread (DS)

A) For short (60m) sweeps: $WS_{60m\ sweeps} = 40.0741 + 01.9259 * DS$; $r^2 = 0.37$

B) For long (110m) sweeps: $WS_{110m\ sweeps} = -23.414 + 6.931 * DS$; $r^2 = 0.74$

Distance (Dist)

Normally recorded by GPS every 1 minute, but if not available, estimated based on haul duration (HaulDur, in minutes) and speed over ground (GroundSpeed, in knots):

Dist = HaulDur / 60 ∗ 1852 ∗ GroundSpeed

Table 1. History of gear modifications and details of which data were used for the calculations.

Survey	Ship	Years	Sweep length	Other modifications	Data used in calculation
Q1	Håkon Mosby	2004-2008			*data not clean, not used
Q1	GO Sars	2009-2015	60 m at depths < 70m 110 m at depths $\geq$ 70 m		2009-2015, GO Sars, 60 & 110 m sweep lengths
Q3	Håkon Mosby	2003-2005			*data not clean, not used
Q3	Johan Hjort	2006-2014	60 m sweeps except: 110 m $\geq$ 70 m in 2011, 2013, and 110m in 2012 (all stations)	Strapping was used when 110 m sweeps were used in 2011-2013	2006-2008, 2010-2011, 2013 (60 m sweeps only); 2006-2008 data not 'cleaned' in latest cleaning round

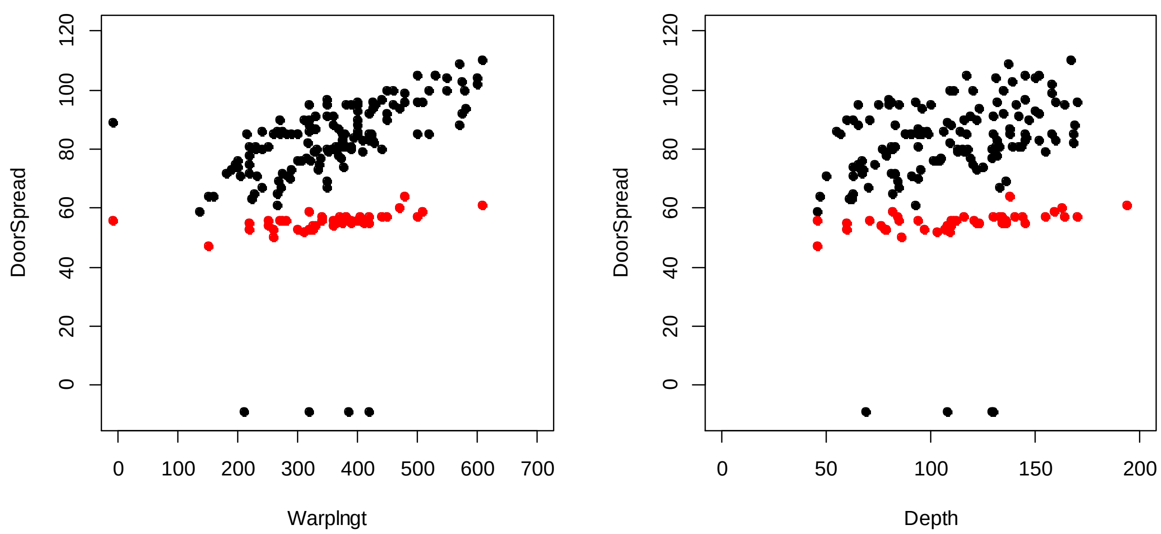


Fig. 1: Door spread vs warp length (left) and door spread vs. depth (right) relationships for Johan Hjort Q3, 2006–2014; rigging for both plots was 60 m sweeps (no strapping). Data for 2014 are highlighted in red. Missing values are indicated by the -9 values.

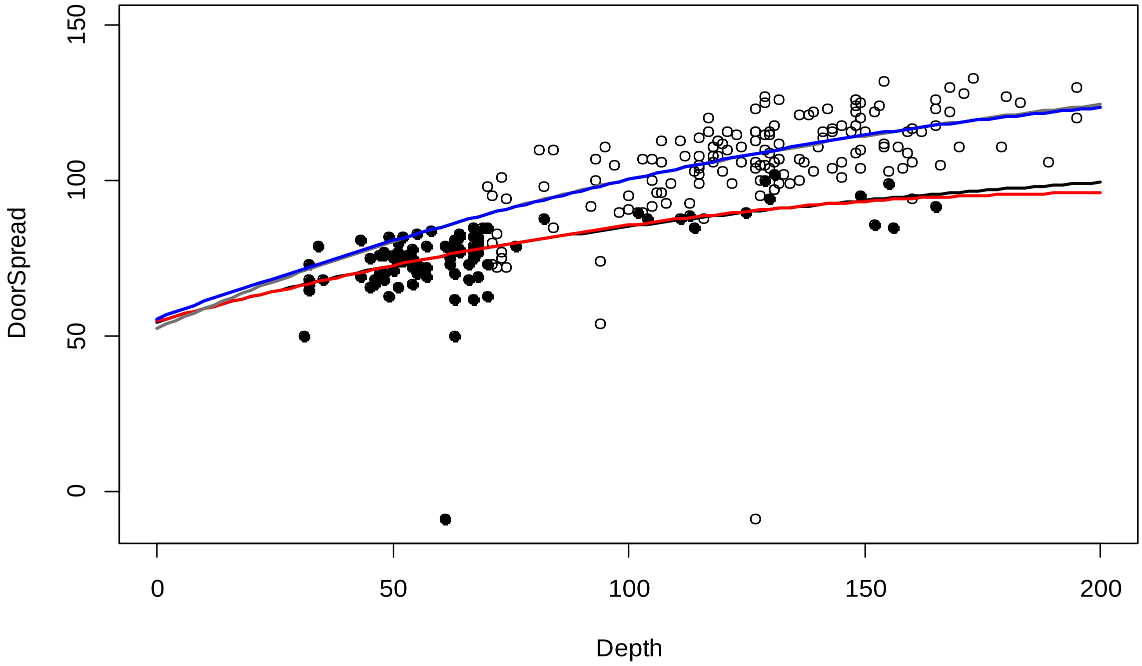


Fig. 2: Depth – Door spread relationships for the Norwegian NS-IBTS 1st quarter surveys 2009–2015 (GO Sars only data). Lines are the fit of the curve using equation 1 for short (black; quasi-r^2 = 0.50) and for long sweeps (dark grey; quasi-r^2 = 0.31), while those fit using equation 2 are in red (short sweeps; r^2 = 0.50) and blue (long sweeps; r^2 = 0.30). Values at -9 are missing door spread values. The used sweep lengths were in accordance to the guidelines in the NS-IBTS manual, i.e. the change from 60 to 110 m sweeps at depths > 70 m in the 1st quarter surveys.

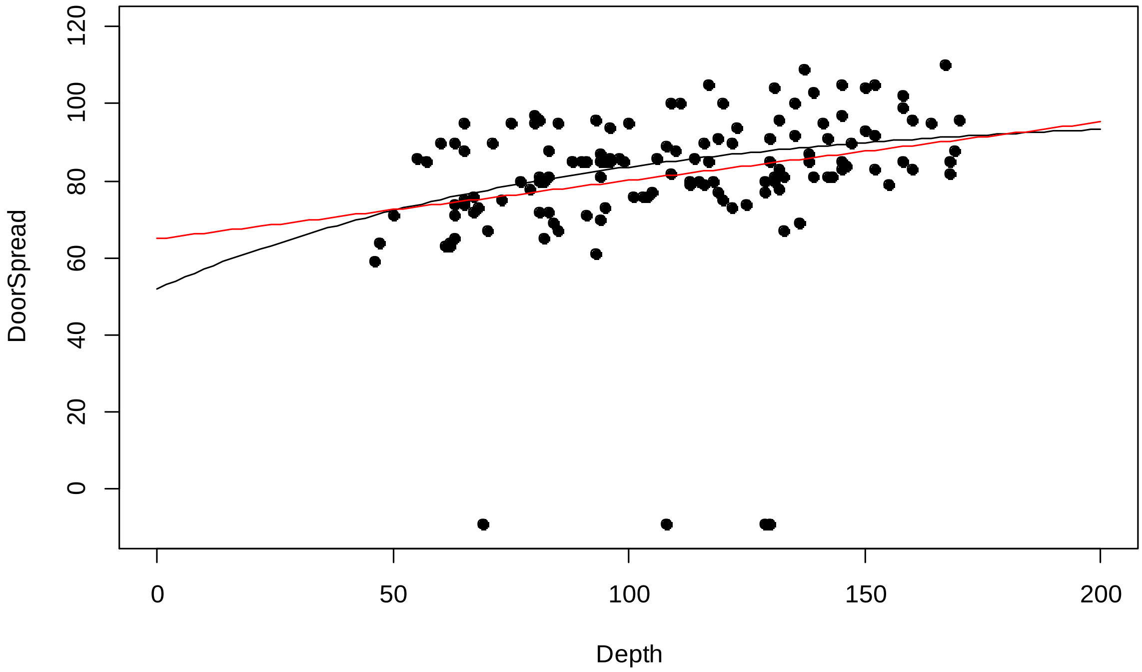


Fig. 3: Depth – Door spread relationships for the Norwegian NS-IBTS 3rd quarter surveys 2006–2013 (Johan Hjort data); 60 m sweep length-only data. Line in black is the fit of the curve using equation 1 for short sweeps (quasi-r^2 = 0.23), while line in red is the fit using equation 2 (r^2 = 0.06). Values at -9 are missing doorspread values. The used sweep lengths were in accordance to the guidelines in the NS-IBTS manual, i.e. 60 m sweeps at all depths and no strapping.

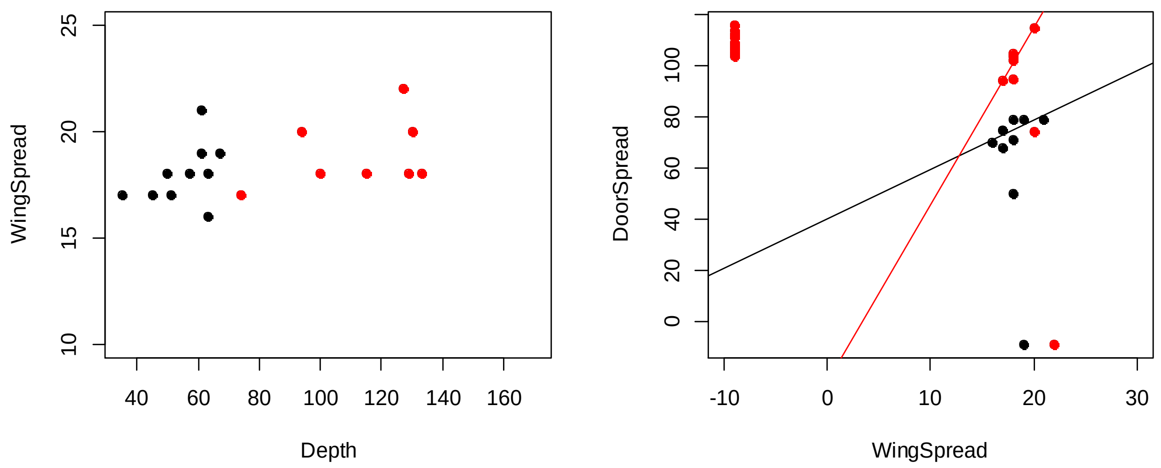


Fig. 4: Wing spread in relation to depth (no limits specified in the IBTS Manual) and wing spread in relation to door spread for 60 m sweeps (black points and line) and 110 m sweeps (red points and red line). Missing values in door spread and wingspread are indicated by -9 values. The error in door spread for 110 m sweeps (74 m door spead) value was excluded from the regression estimation).

Doorspread, Wingspread and Distance - French data of the IBTS 2004-2014.

The French IBTS records door spread and wings spread. Only the 50 meters sweeps are used.
The 2004-2010 data was collected with Scanmar equipment, 2011-2014 with Marport equipment.

Between 2004 and 2014, 44 values were missed for door spread an 333 for wing spread.

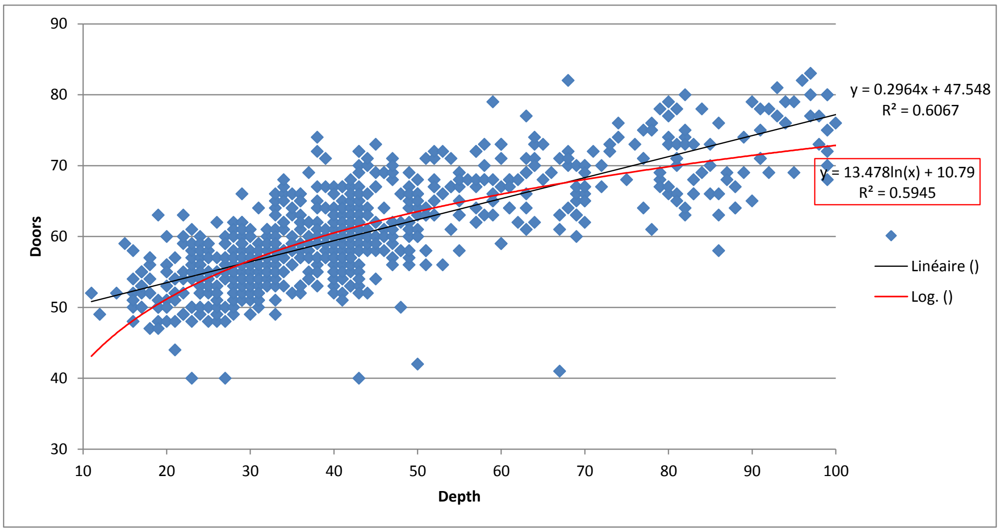
To calculate the missing values, the Danish formula (Wieland-IBTSWG-report 2014) was used :

- doors spread based on the depth

- wings spread, (based on door spread).

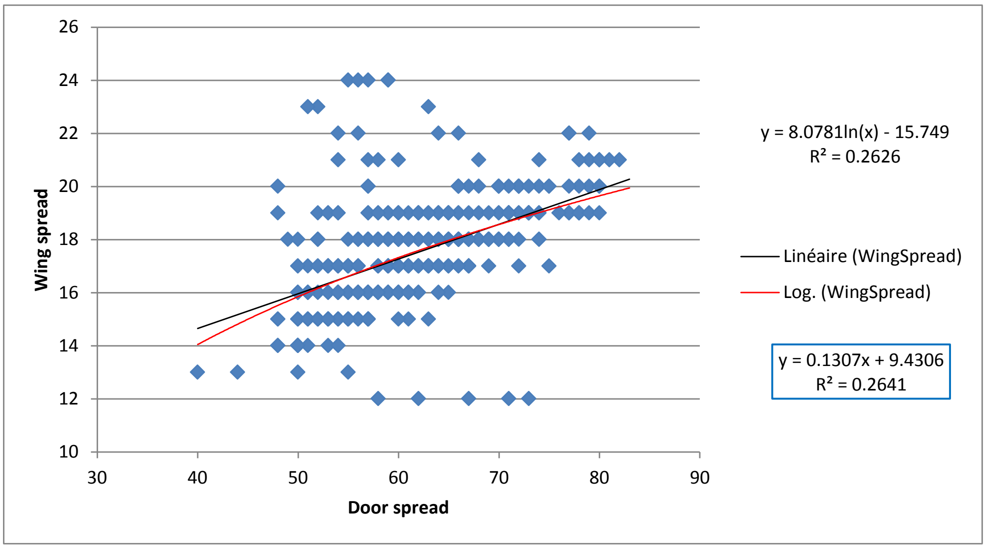
DoorSpread (DS) Vs Depth (D)

Formula	R^2	p-value	Nb observations
DS = 47.548 + 0.296*D	0.61	<0.001	813 (dark line)



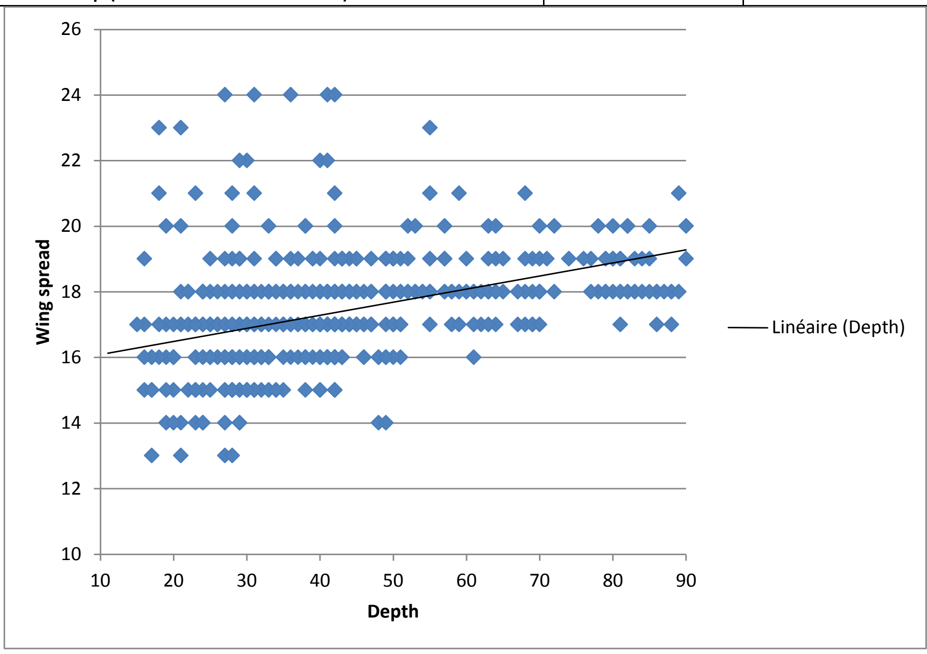
WingSpread (WS) Vs DoorSpread (DS)

Formula	R^2	p-value	Nb observations
WS = 9.431 + 0.131*DS	0.264	<0.001	517



WingSpread (WS) vs Depth (D)

Formula	R^2	p-value	Nb observations
WS = 15.720 + 0.038*D	0.164	<0.001	524 (red line)
WS = 11.097 + 1.705 log(D)	0.151	<0.001	524 (blue line)
WS = exp(15.703+0.00219*D)	0.167	<0.001	524 (green line)



Distance (Dist)

Based on haul duration (HaulDur, in minutes) and speed over ground (GroundSpeed, in knots)

Dist = HaulDur / 60 * 1852 * GroundSpeed

Interpolating missing observations required for swept area calculation in the 1st and 3rd quarter North Sea IBTS for Germany, 2004 – 2014.

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Introduction

The importance of swept-area estimation was highlighted by IBTSWG in 2013 following recommendations by WGISDAA (Working Group on Improving use of Survey Data for Assessment and Advice) and WKDATR (DATRAS data review priorities and checking procedures). Prior to calculating any swept area-based indices, it was necessary to review the recording and availability of the existing parameter data needed for such an estimation, namely door and wing spread and distance travelled during haul. Several gaps and errors in the national data sets stored in DATRAS were identified and all countries were asked to check and, if appropriate, to re-upload corrected data for the time period 2004-2014 and to provide algorithms for estimating missing values needed for the calculation of swept area, i.e. towed distance, door spread (for herding species) and wing spread (for non-herding species (ICES 2013).

Germany used the same survey vessel 'Walther Herwig III' the all years of the specified time period. All German IBTS hauls in the respective data set have been conducted using the Grand Overture vertical (GOV) bottom trawl with ground gear A. During fishing hauls, which formed the German contribution to the North Sea IBTS, door spread and wing spread of the GOV otter board trawl have been routinely monitored applying Scanmar Sensors. For a limited number of hauls, where either one or both of these parameters could not be recorded, regression functions for fill-ins of missing values were derived from the 2004-2014 data set as specified below.

Regression Models for fill-ins of missing values in German IBTS Data (2004-2014)

Horizontal net opening

Wing spread and door spread of the GOV are strongly correlated (Fig. 1), but also depend on depth.

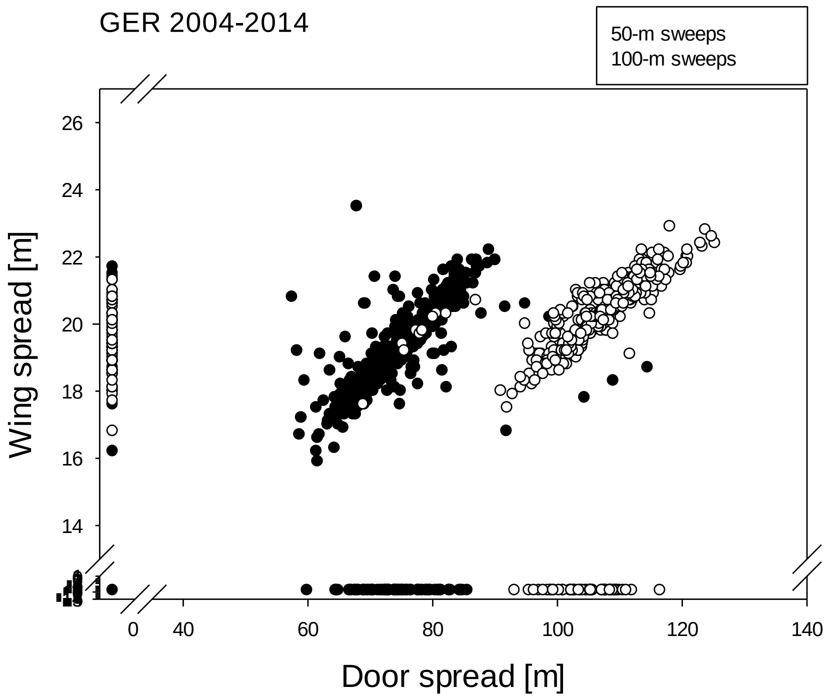

Fig. 1 Wing spread-to-door spread relationship in German IBTS Q1 and Q3, data before fill-in's of missing data of either one. Data from 2004-2014. Following the previous NS-IBTS manual, rev. VII, long sweeps (100 m) were applied during Q1 at depth > 70 m until 2012.

Door Spread

Values for door spread (DS) were missing in 73 out of 998 cases (compare Fig. 2). Two independent regression functions were used for 50 m and 100 m sweeps, respectively. In each case, the final primary model does not consider warp length (WL), but wing spread (WS) and depth (D):

DS = -7.456 + 3.616 * WS + 3.124 * log(D) — **- primary model DS1 (short = 50-m sweeps)**

$r^2 = 0.77$, $p<<0.001$ — (‘log’ = ln, natural logarithm; 20 cases of fill-in’s needed for time period 2004-2014)

DS = -7.935 + 5.123 * WS + 2.366 * log(D) — **- primary model DS2 (long = 100-m sweeps)**

$r^2 = 0.77$, $p<<0.001$ — (52 cases for 2004-2014)

Only one case occurred in the German 2004-2014 time series, where apart from door spread, also the wingspread values were missing. For this particular situation, the most parsimonious model was the following, based on warp length and depth:

DS = -0.441 + 10.009 * log(WL) + 4.768 * log(D) — **- secondary model DS3 (50-m sweeps)**

$r^2 = 0.94$, $p<<0.001$ — (1 case for 2004-2014)

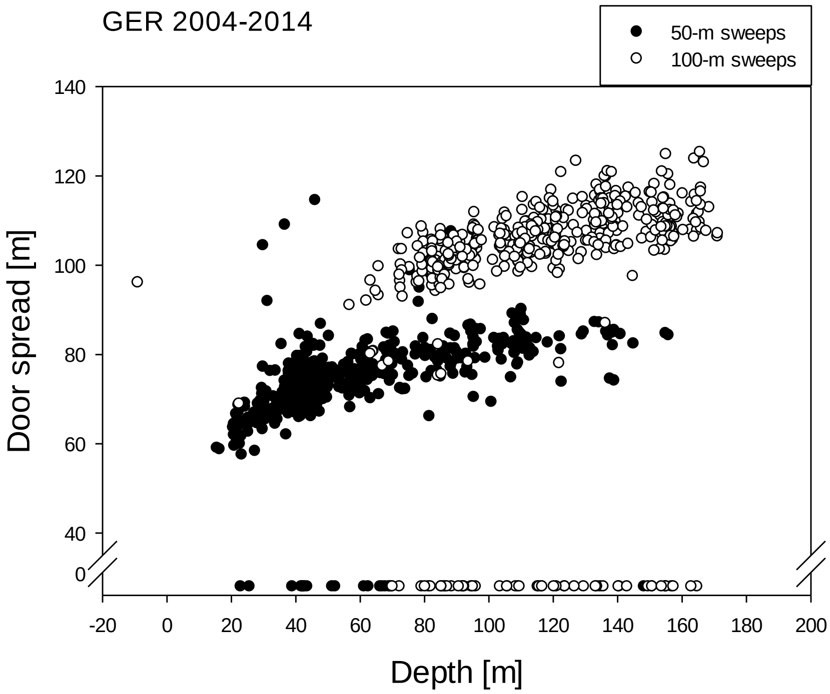

Fig. 2 Door spread-to-depth relationship in German IBTS Q1 and Q3, data before fill-in’s of missing data of door spread. Data from 2004-2014.

Wing Spread

Values for wing spread (WS) were missing in 121 out of 998 cases (compare Fig. 3). Again, model subsets were applied for 50 m and 100 m sweeps. In each case, the primary model (using door spread DS, warp length WL and depth D) gives the best result for calculating wing spread:

WS = 3.359 + 0.095 * DS + 1.391 * log(WL) + 0.261 * log(D) **- primary model WS1 (50-m sweeps)**

r^2= 0.83, p<<0.001 (68 cases for 2004-2014)

WS = 3.087 + 0.118 * DS + 0.445 * log(WL) + 0.368 * log(D) **- primary model WS2 (100-m sweeps)**

r^2= 0.78, p<<0.001 (53 cases for 2004-2014)

In case of missing parameters, the respective secondary model would need to be used. Listed here is the model for the single incident, for which this was relevant for the German 2004-2014 time series (due to simultaneously missing values for wing spread and door spread in one case):

WS = 3.317 + 2.341 * log(WL) + 0.713* log(D) **- secondary model WS3 (50-m sweeps)**

r^2= 0.69, p<<0.001 (1 case for 2004-2014)

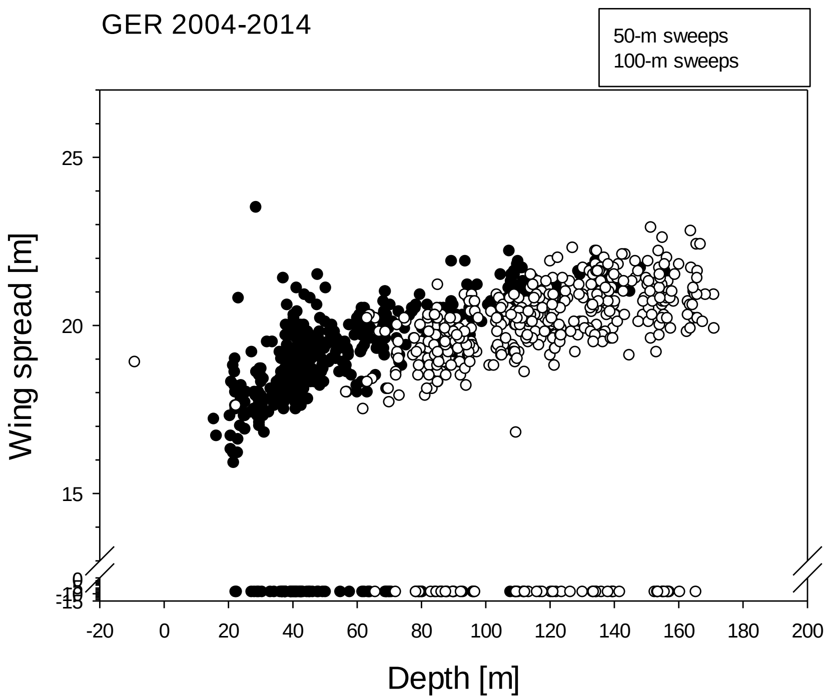

Fig. 3 Wing spread-to-depth relationship in German IBTS Q1 and Q3, data before fill-in's of missing data of wing spread. Data from 2004-2014.

Distance Towed

During the time series 2004-2014, distance values were typically obtained through calculation from haul duration and speed over ground, and will be marked with the flag "C" (calculated) in the flex file. In this, speed over ground was obtained as the mean of measurements taken throughout the haul, every 30 sec (each measurement being the mean of a 10-sec interval).

Distance towed (DT) DT = dur/60*1852*SOG

In a few cases, where differences between the distance calculated with the method described above, and the point-to-point distance between shoot and haul position was greater than 200 m, the distance was manually corrected and marked with the flag "O" (observed). These values represent the sum of point-to-point distances measured at 30-sec intervals (n = 11).

References

ICES 2013: Report of the International Bottom Trawl Survey Working Group (IBTSWG). ICES CM 2013/SSGESST:10.

Gear Standardization - Net plans and gear components tables

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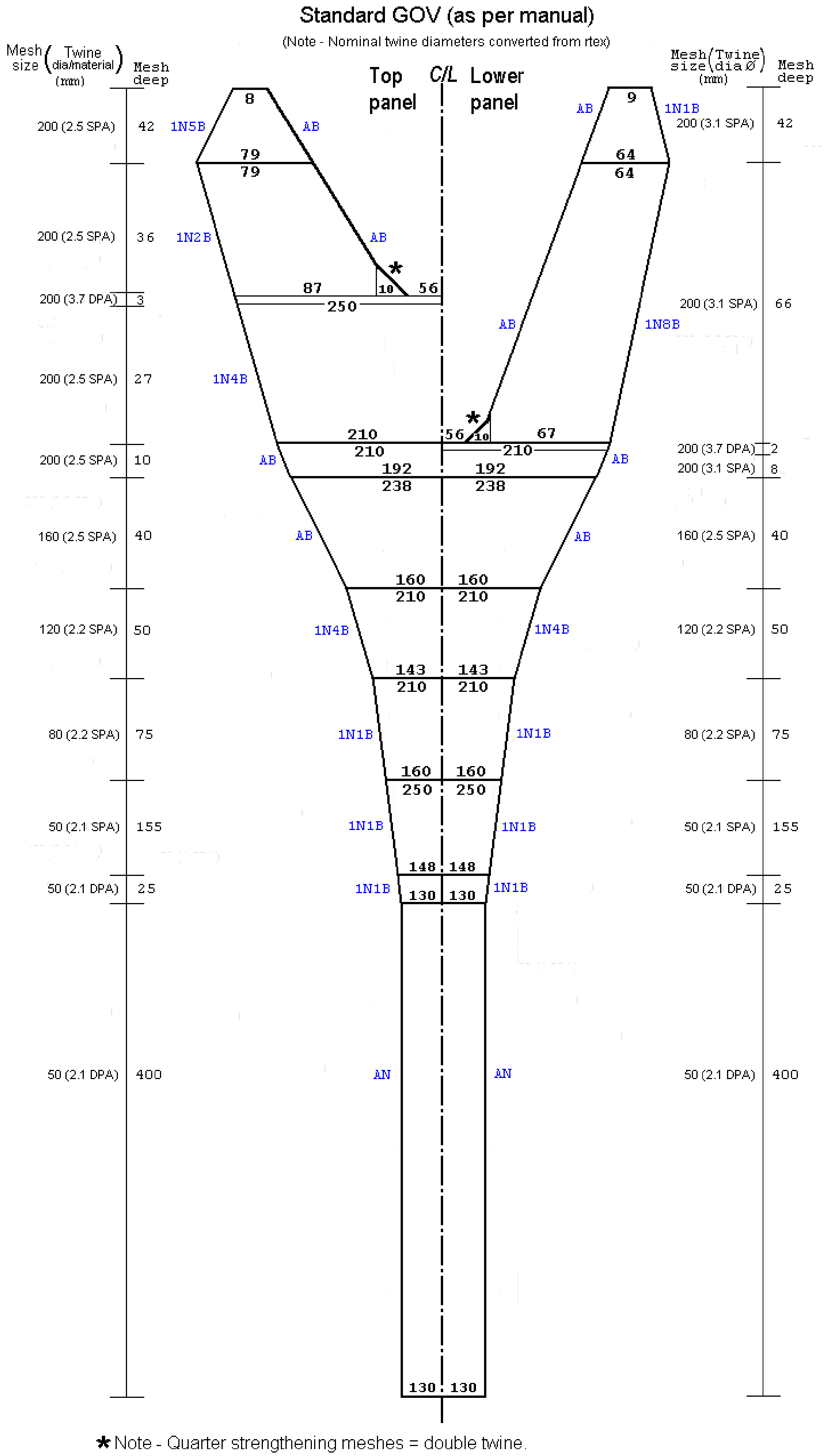
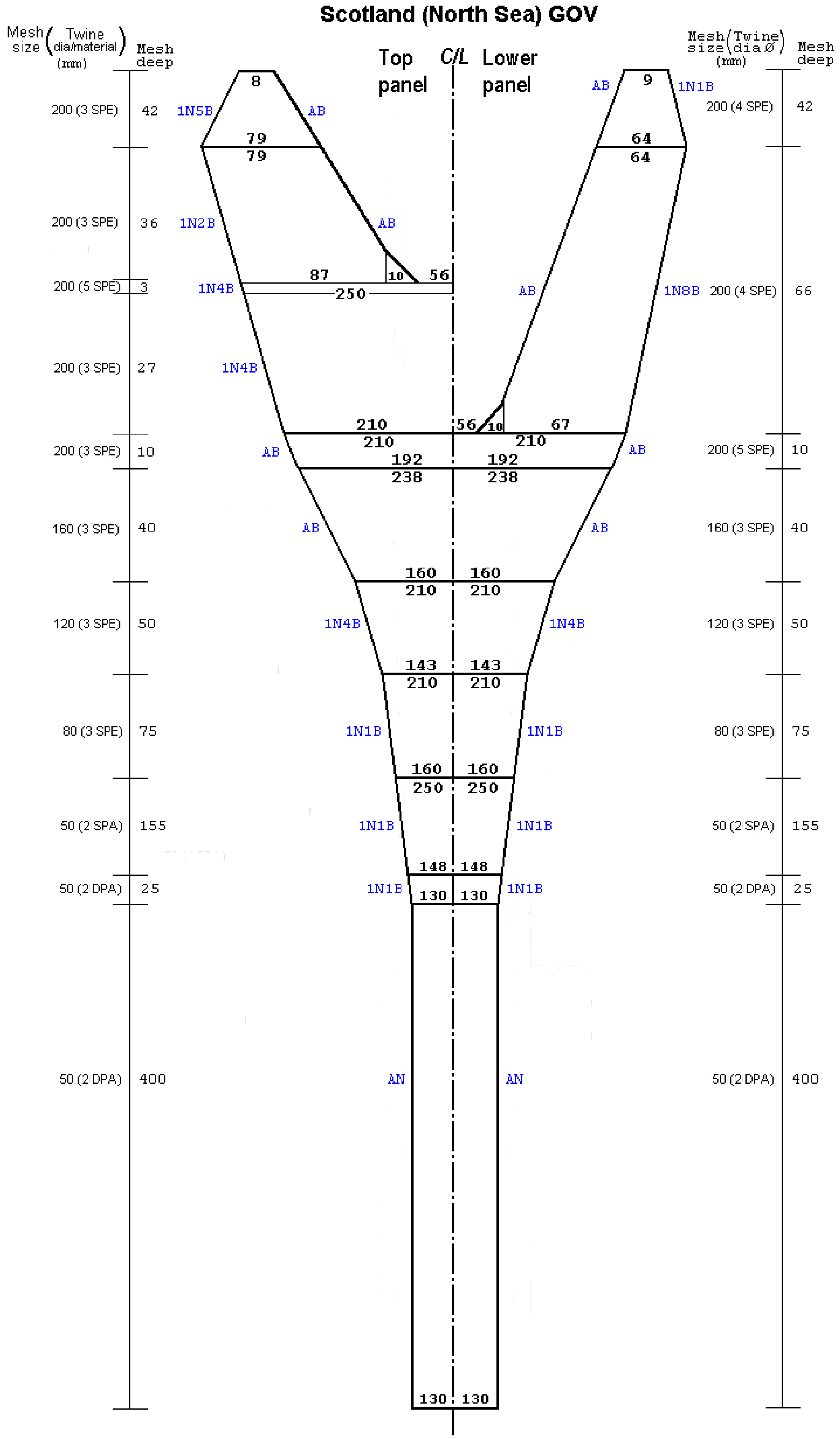
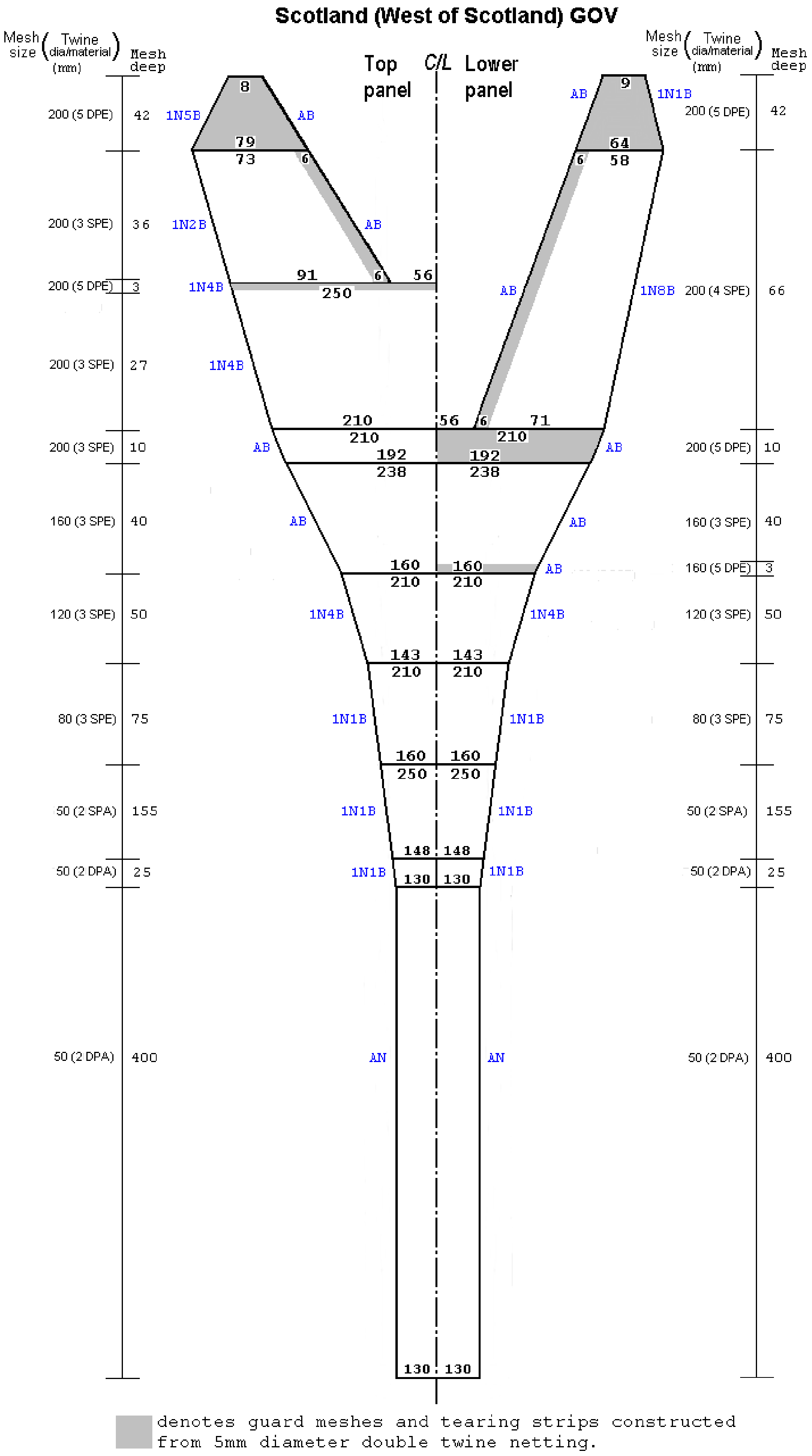


Figure 1: GOV net plan as per Manual for the International Bottom Trawl Surveys



Note - Quarter meshes 200mm x 5mm Single PA twine.

Figure 2: UK Scotland (SCO) North Sea GOV net plan



denotes guard meshes and tearing strips constructed from 5mm diameter double twine netting.

Figure 3: UK Scotland (SCO) west of Scotland GOV net plan

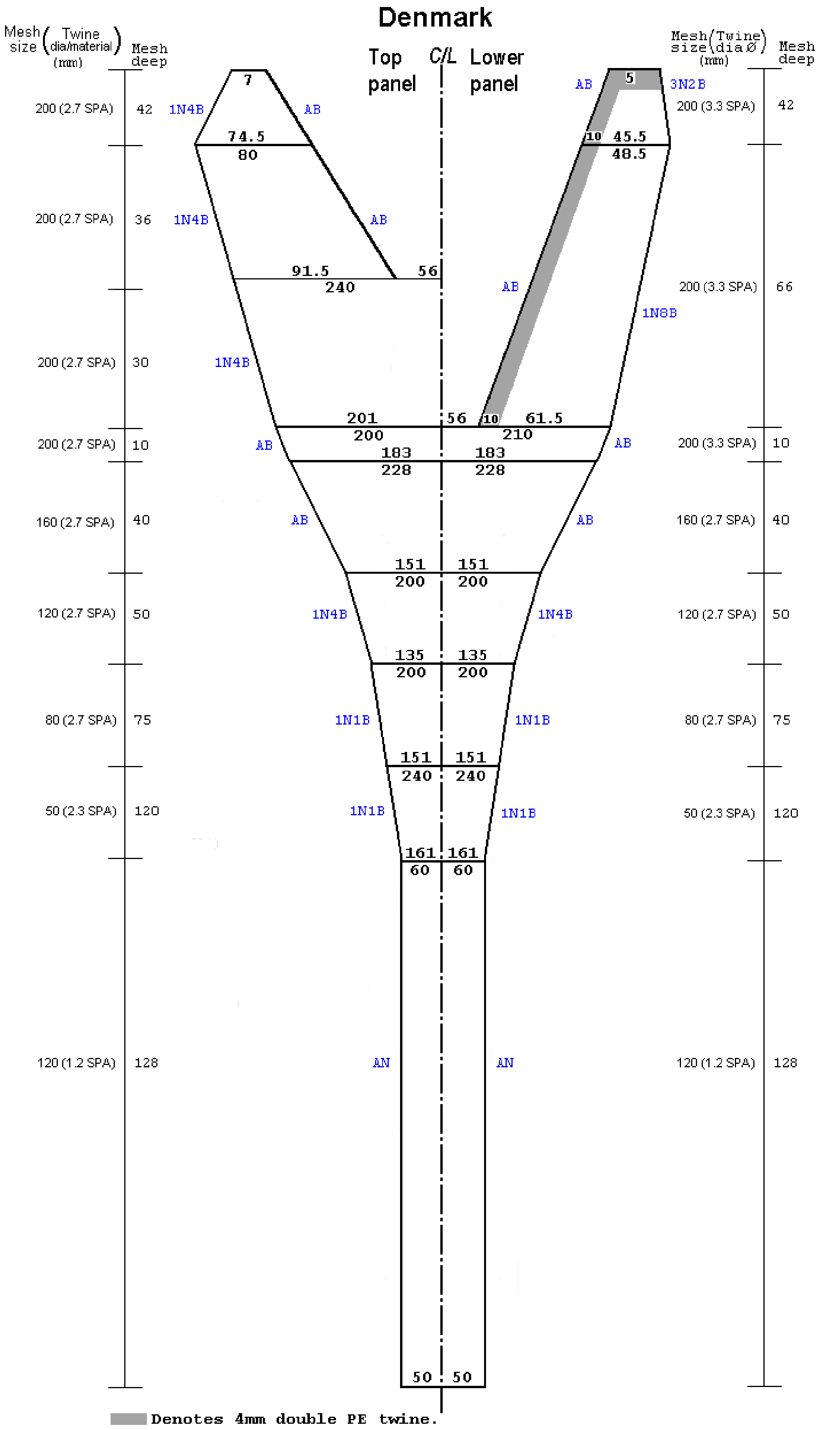


Figure 4: Denmark (DEN) GOV net plan

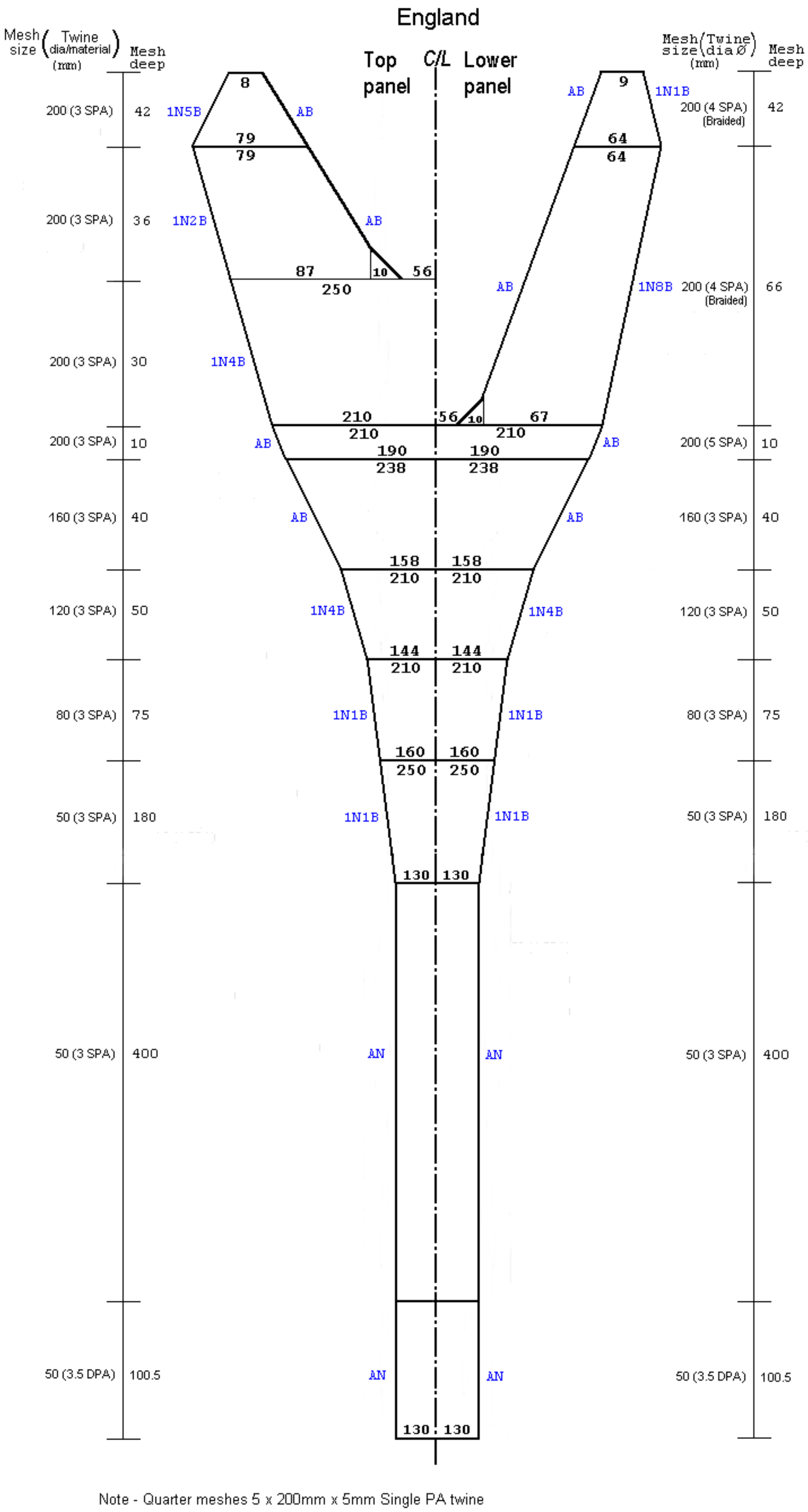


Figure 5: UK England (ENG) GOV net plan

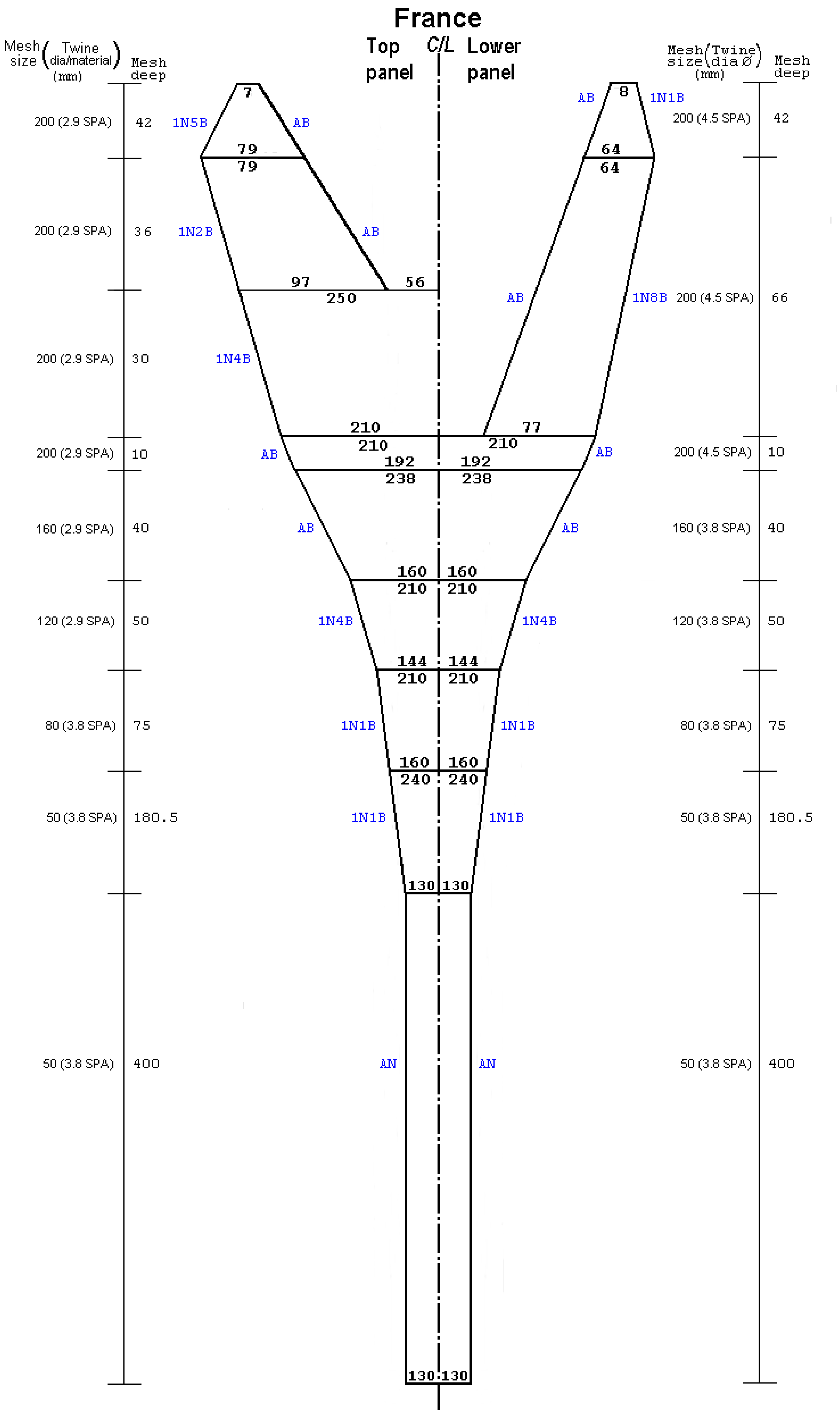
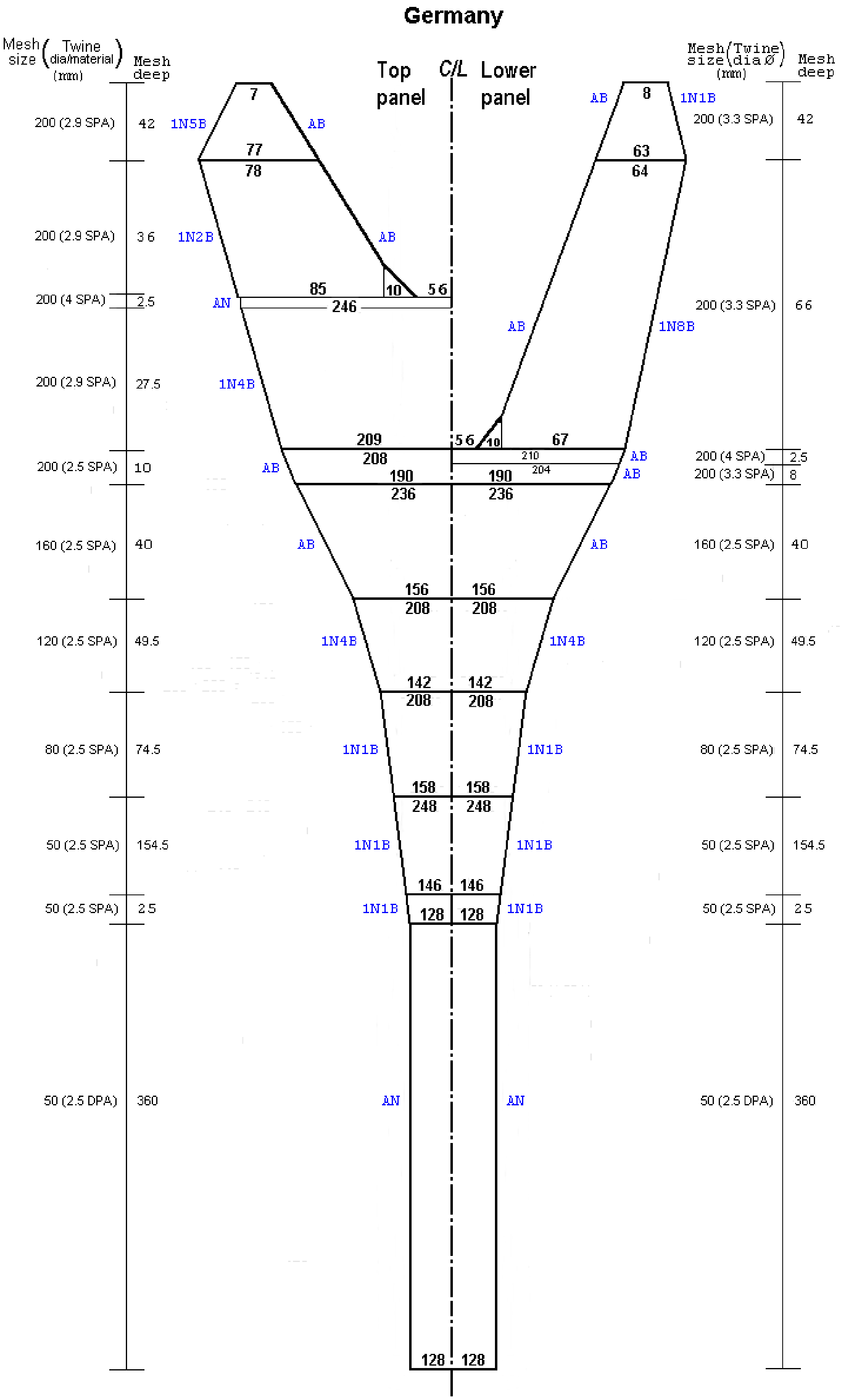


Figure 6: France (FRA) GOV net plan



Note - Quarter meshes 200mm x 4mm Single PA twine.

Figure 7: Germany (GER) GOV net plan

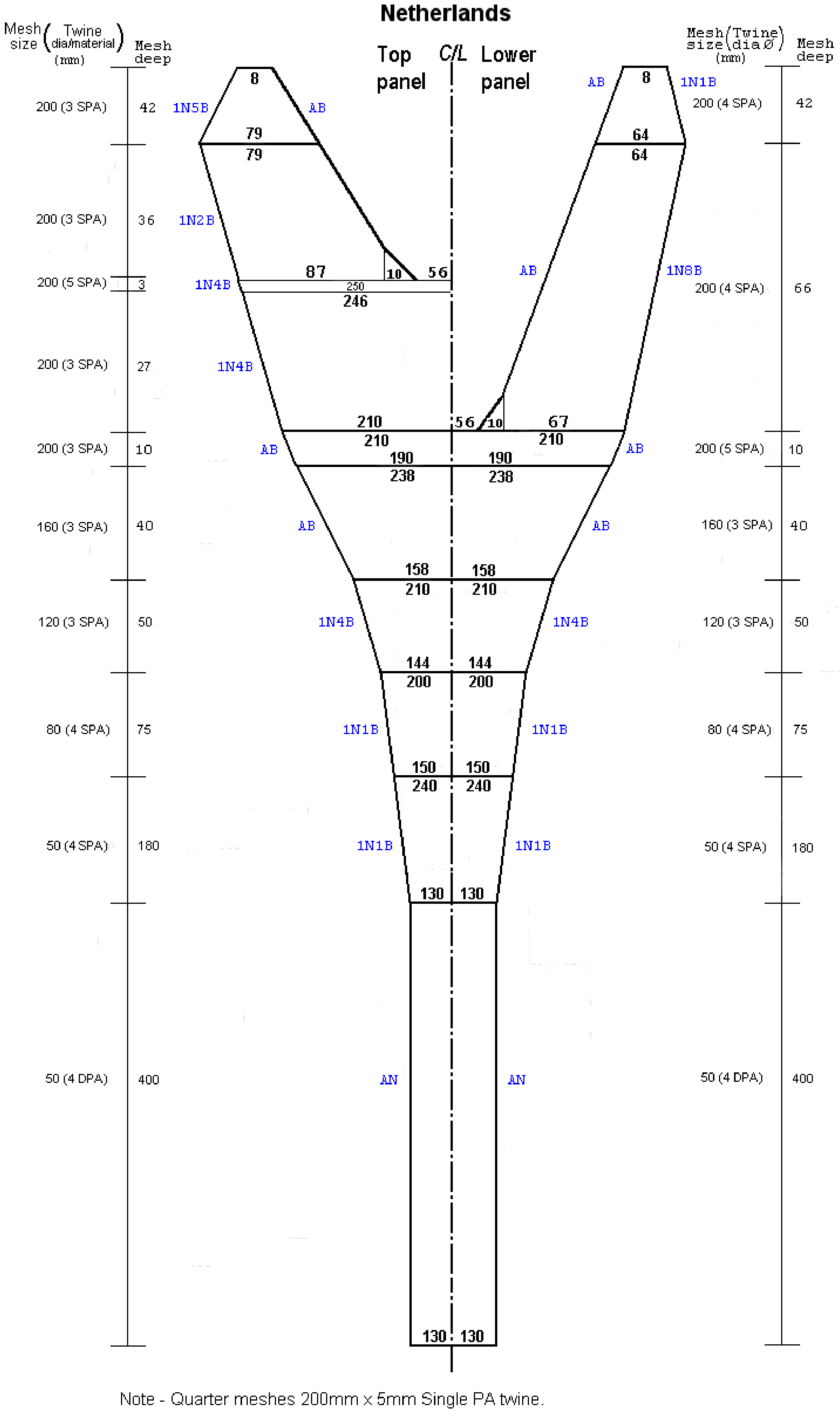


Figure 8: Netherlands (NED) GOV net plan

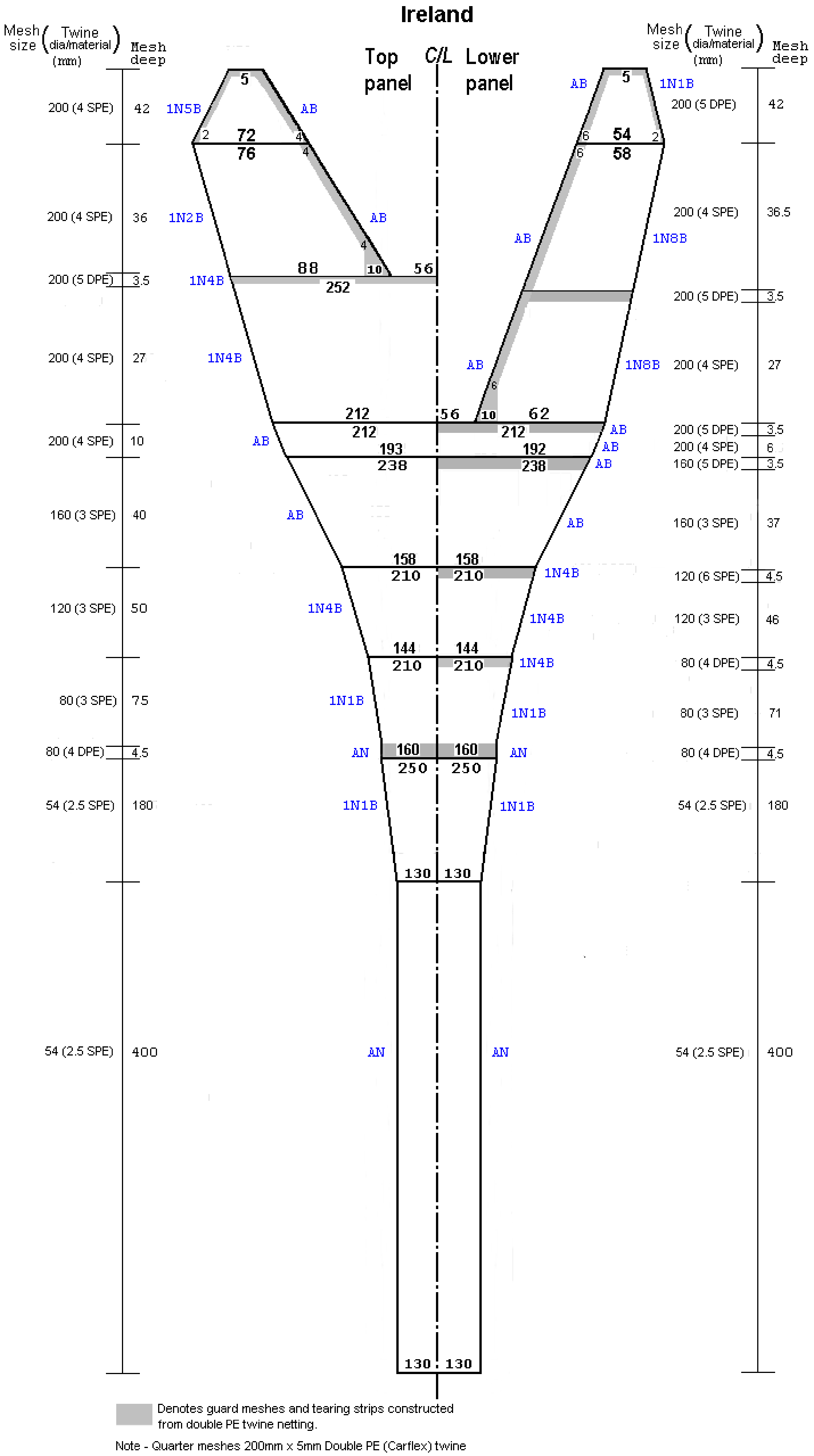
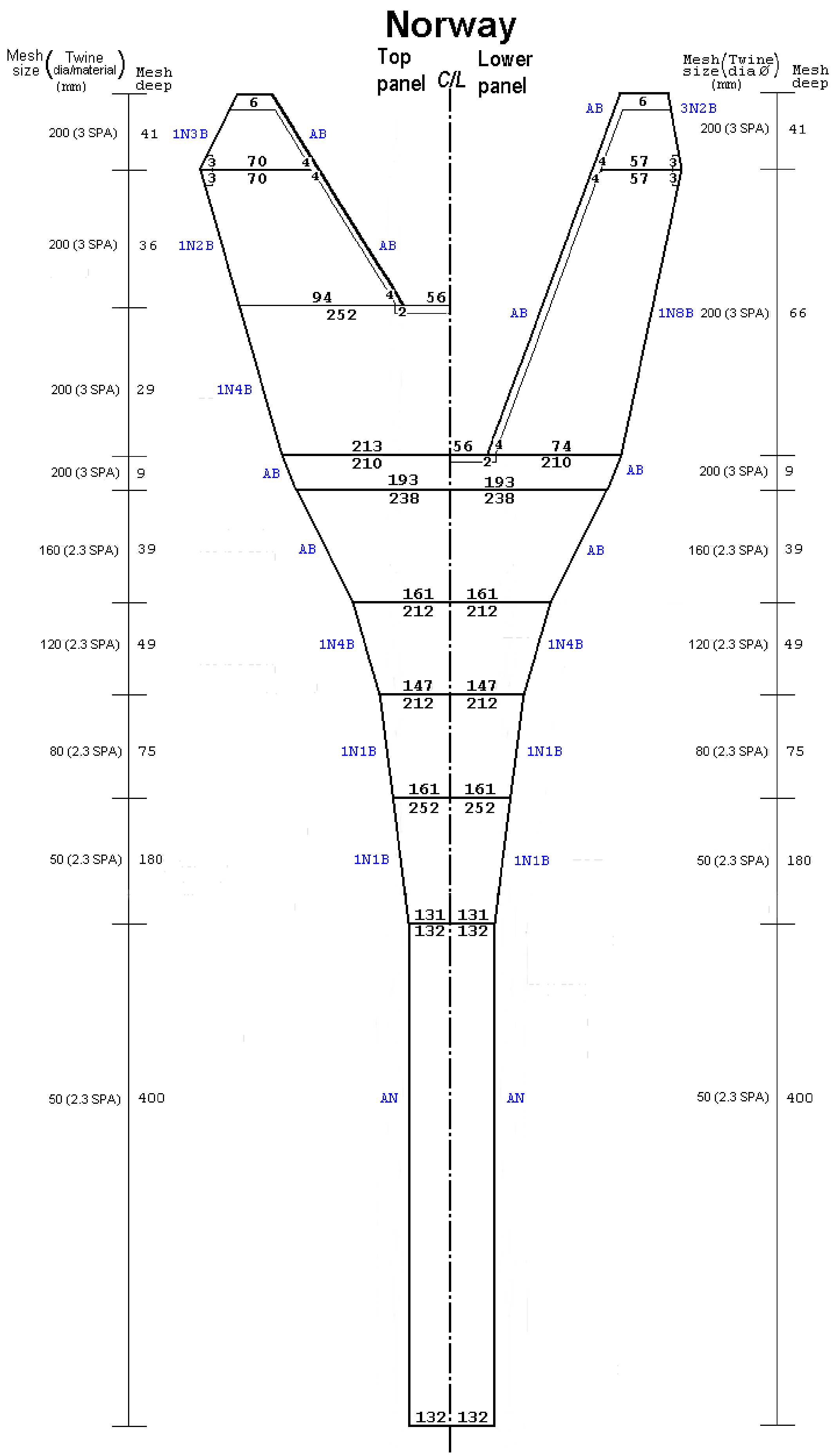


Figure 9: Ireland (IRE) GOV net plan



Note - Strengthening meshes (wings, headline & footrope) constructed from 200mm x 5mm Single PA twine.

Figure 10: Norway (NOR) GOV net plan

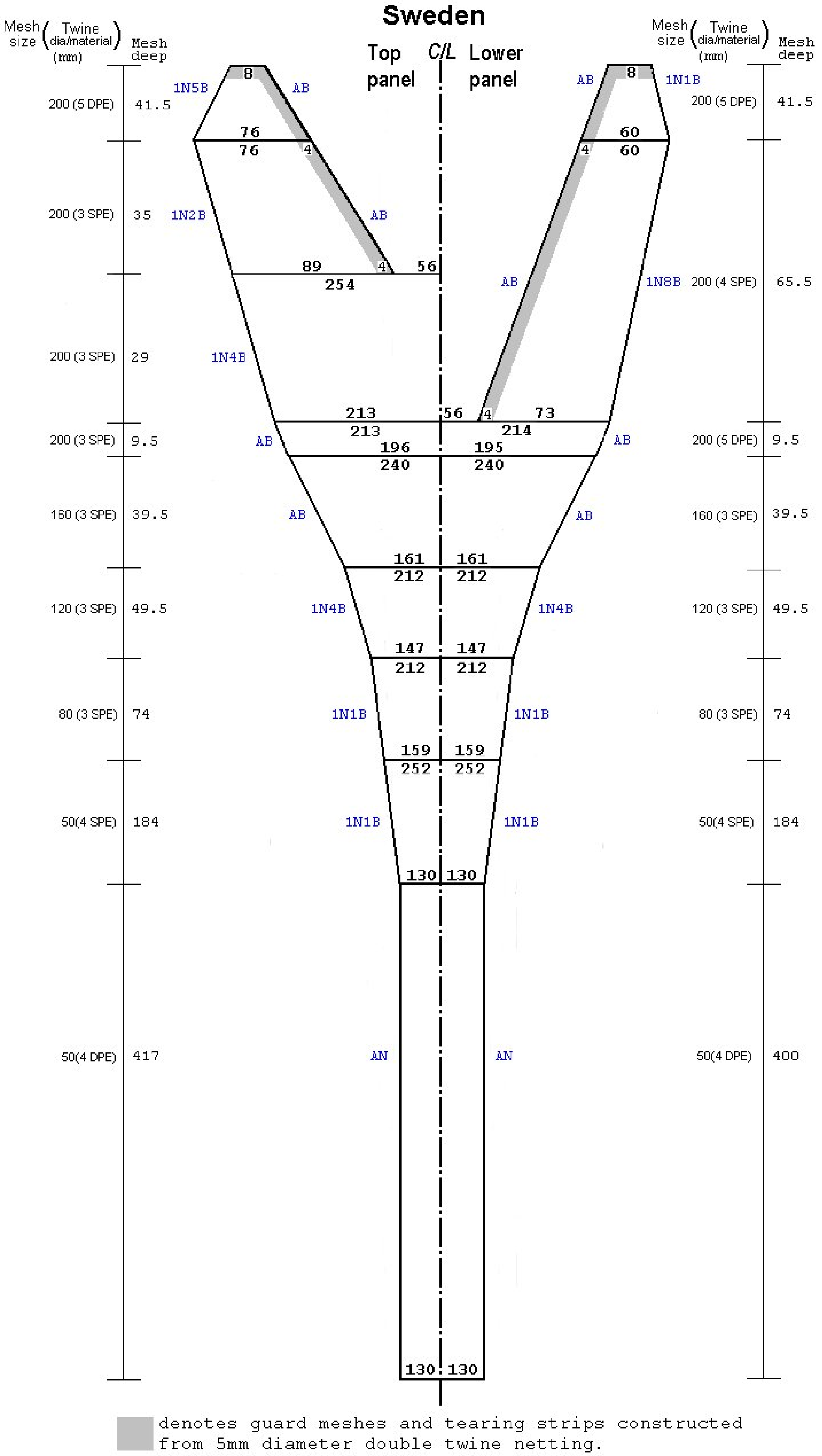


Figure 11: Sweden (SWE) GOV net plan

Codend liner and twine area calculations	Standard	UK (Scotland) North Sea	UK (Scotland) W of S & Rockall	UK (England)	France	Germany	Norway	Sweden	Denmark	Netherlands	Ireland
Codend liner											
Number of meshes in circumference	600	600		600	600	410	600	600	600	600	600
Length – Number of meshes	400	400		404	400	400	399.5	410	600	400	320
Nominal twine diameter (mm)	1.03	1.8		1.02	4	2.5	1.6	N/R	1.2	1.8	1.8
Trawl twine area calculations											
Main trawl body - Top & lower tapered panels combined (m^2)	86	102	128	107	121	91	87	119	87	118	138
Straight section - 2 panels (m^2)	22	42	42	18	40	46	24	87	4	83	28
Codend liner – 2 panels (m^2)	10	18	18	10	19	16	15	18	17	17	14

Table 1: Codend liner and twine area calculations (Column 1 is standard rigging as per Manual for the International Bottom Trawl Surveys)

Trawl roping and framelines	Standard	UK (Scotland) North Sea / W of S & Rockall	UK (England)	France	Germany	Norway	Sweden	Denmark	Netherlands	Ireland
Middle bridle extension - Length (m) Diameter (mm) Material	7.1 14 Wire	**7.1** 14 Wire	**7.08** 20 Combi	**7.1** 16 Combi	**6.5** 14 Wire	**7.1** 14 Wire	**8.38** 20 Combi	**7.1** 22 Combi	**7.1** 14 Wire	**7.05** 20 Combi
Middle bridle adjuster chain - used (Y/N) and Min (m) / Max (m)	No info	N	N	Y (N/R)	Y (0.6 to 1.0)	N	N	Y (N/R)	N	N
Bolt rope 1st section – Length (m) Diameter (mm) Material	6.7 20 Combi	**6.7** 22 Combi	**6.7** 20 Combi	**6.7** 18 Combi	**6.7** 20 Combi	**6.7** 20 Combi	**7.04** 16 Combi	**6.7** 20 Combi	**6.7** 22 Combi	**12.17** 20 Combi
Bolt rope 2nd section – Length (m) Diameter (mm) Material	5.55 20 Combi	**5.55** 22 Combi	**5.5** 20 Combi	**5.5** 18 Combi	**5.55** 20 Combi	**5.55** 20 Combi	**9.28** 16 Combi	**5.5** 20 Combi	**5.55** 22 Combi	N/A
Selvedge rope – Length (m) Diameter (mm) Material	*L for L 22 Nylon	**49.4** 20 Polysteel & nylon	N/R	**48.6** 20 Nylon	**47.7** 24 Combi+ nylon	N/R 20 Nylon	**28.65** 20 Polyprop	N/R	**20.4** 20 Polyprop	***L for L** 22 Polysteel
Headline – Length (m) Diameter (mm) Material	36 14 Wire wrapped	**36** 22 Combi	**36.1** 18 Wire	**36** 14 Wire	**36.2** 14 Wire wrapped	**36** 14 Wire wrapped	**37.67** 22 Combi	**39.4** 22 Combi	**36** 14 Wire	**36** 20 Combi
Footrope – Length (m) Diameter (mm) Material	47.2 22 Combi	**47.2** 22 Combi	**47.2** 20 Combi	**45.8** 22 Combi	**47.4** 24 Combi	**47.2** 22 Combi	**48.9** 24 Combi	**52.8** 13 Chain	**47** 22 Combi	**47** 22 Combi
Upper wing-line – Length (m) Diameter (mm) Material	8.2 20 Combi	**8.2** 22 Combi	**7.7** 18 Combi	**8.2** 18 Combi	**8.2** 22 Combi	**8.2** 22 Combi	**8.05** 24 Combi	**8.2** 20 Combi	**8.2** 22 Combi	**8.173** 20 Combi
Lower wing-line – Length (m) Diameter (mm) Material	8.2 20 Combi	**8.2** 22 Combi	**7.75** 18 Combi	**8.2** 18 Combi	**8.2** 22 Combi	**8.2** 22 Combi	**8.07** 24 Combi	**8.2** 20 Combi	**8.2** 22 Combi	**8.173** 20 Combi

* Note – L for L = Bolt rope rigged length for length along the selvedge

Table 2: Trawl roping and framelines (Column 1 is standard rigging as per Manual for the International Bottom Trawl Surveys)

Flotation and kite.	Standard	UK (Scotland)		UK (England)	France	Germany	Norway	Sweden	Denmark	Netherlands	Ireland
		North Sea	W of S & Rockall								
Flotation - total number (and diameter mm).	60 (200)	60 (200)		60 (200)	60 (200)	70 (200)	60 (200)	22 (270)	89 (150)	60 (200)	66 (200)
Total buoyancy (kg)	172	148.2		174	180	178.5	153.6	187	150	171.6	204.6
Is kite used (Y/N)	Y	Y		Y	Y - NS only	Y	Y	Y	Y	Y	N
If Y - dimension (L x W) (m) and material (+ attached to headline)	**0.85 x 0.85** Aluminium (frame)	**0.85 x 0.85** Aluminium (frame)		**0.6 x 0.6** Aluminium (frame)	**0.85 x 0.85** Aluminium (frame)	**0.85 x 0.85** Aluminium (no frame)	**0.85 x 0.85** Aluminium (frame)	**0.85 x 0.85** Aluminium (ropes only)	**0.85 x 0.85** Aluminium (ropes only)	**1.0 x 1.0** Ply Wood (ropes only)	N/A
Integrated kite flotation – total number and (diameter mm)	5 (200)	5 (200)		5 (200)	5 (200)	5 (200) + 1 x 15ltr fender	5 (200)	5 (180)	5 (180)	1 x 15ltr fender	N/A
If N – Number (and diameter mm) added to compensate for kite	N/A	N/A		N/A	12 (200)	N/A	N/A	N/A	N/A	N/A	10 (280)

Table 3: Flotation and kite (Column 1 is standard rigging as per Manual for the International Bottom Trawl Surveys)

Otterboard specification	Standard	UK (Scotland)		UK (England)	France	Germany	Norway	Sweden	Denmark	Netherlands	Ireland
		North Sea	W of S & Rockall								
Otterboards – Type	Polyvalent	Polyvalent		Polyvalent	Polyvalent	Polyvalent	Polyvalent	Vee Doors	Polyvalent	Polyvalent	Polyfoil
Otterboards – Surface area (m2)	4.5	4.46		6.2	4.46	4.5	4.46	5.57	4.5	4.5	5.2
Otterboards – Weight in air (kg)	No info	1100		1500	1280	1500	1075	1080	N/R	1100	1400

Table 4: Otterboard specification (Column 1 is standard rigging as per Manual for the International Bottom Trawl Surveys)

Ground gear and adjuster chain assembly.	Standard	UK (Scotland)		UK (England)	France	Germany	Norway	Sweden	Denmark	Netherlands	Ireland
		North Sea	W of S & Rockall								
Ground Gear A - Total length (m) Total weight in air (kg)	45 to 45.8 705	45 949	N/A	45 1025	46 N/R	45.55 N/R	47 705	48.55 N/R	52.6 N/R	45.8 705	46.8 1106
Bosom section – Length (m), (diameter mm) and material.	5 (200) Disc	5 (200) Disc	N/A	5 (200) Disc	5 (200) Disc	5.05 (200) Disc	5 (200) Disc	5.05 (200) Disc	5 (200) Disc	5 (200) Disc	5 (200) Disc
Quarter sections – Length (m), (diameter mm) and material.	10 (200) Disc	10 (200) Disc	N/A	10(200) Disc	10(200) Disc	10.1 (200) Disc	10 (200) Disc	10.1 (200) Disc	10.2 (200) Disc	10.2 (200) Disc	10 (200) Disc
Wing sections – Length (m), (diameter mm) and material	30 (100) Disc	30 (100) Disc	N/A	30(100) Disc	30(100) Disc	30.4 (200) Disc	30 (200) Disc	33.4 (100) Disc	37.4 (100) Disc	30.6 (200) Disc	31.8 (100) Disc
Mounted onto – Diameter (mm) and material.	18 Wire	13 L/L Chain	N/A	22 Wire	14 L/L Chain	18 Wire	20mm Wire & 16mm M/L chain	18 Wire	20 Wire	13 L/L Chain	13 L/L Chain
Ground gear B – or alternative Total length (m) Total weight in air (kg)	45 849	45 840	46 2180	N/A	N/A	N/A	N/A	N/A	N/A	N/A	46.7 2000
Bosom section – Length (m), (diameter mm) and material.	5 (305) Bobbins	5 (305) Bobbins	5 (406) Hoppers	--	--	--	--	--	--	--	5 (400) Hoppers
Quarter sections – Length (m), (diameter mm) and material.	10 (305) ½ Bobbins	10 (305) ½ Bobbins	10 (356) Hoppers	--	--	--	--	--	--	--	20 (360) Hoppers
Wing sections – Length (m), (diameter mm) and material.	30 (150) Disc	30 (150) Disc	20 (356) Hoppers	--	--	--	--	--	--	--	10 (300) Hoppers
Wingend sections – Length (m), (diameter mm) and material.	N/A	N/A	10.5 (305) Hoppers	--	--	--	--	--	--	--	11 (300) Hoppers
Mounted onto – Diameter (mm) and material.	13 M/L chain	13 M/L chain	16 M/L chain	--	--	--	--	--	--	--	16 M/L chain
Adjuster chain assembly											
If fixed – total length (m).	N/A	2.2	2.35	2.0	N/A	2.15	1.8(Q3 only)	1.1	1.5	1.6	N/A
If adjusted - length Min (m)/Max (m).	1.7 – 2.2	N/A	N/A	N/A	2.3 - 2.8	N/A	1.7 – 2.2	N/A	N/A	1.6 or 1.7	1.7 - 2.2
Ground gear A - Bobbin type, diameter (mm)/ weight (kg) and material.	400 / no info Steel spherical	400 / 48 Steel spherical	N/A	400 / 48 Steel spherical	400 / 51 Steel spherical	400 / N/R Steel spherical	200 / N/R Half bunt rubber	305 / N/R Half bunt rubber	305 / 11.8 Half bunt rubber	400 / 20 Half bunt rubber	350 / N/R Half bunt rubber
Ground gear B or alternative – Bobbin type, diameter (mm)/ weight (kg) and material.	400 / no info Steel spherical	400 / 48 Steel round	305 /N/R Half bunt rubber	N/A	N/A	N/A	350 /N/R Half bunt rubber	N/A	N/A	N/A	350 / N/R Half bunt rubber
Adjuster chain – Diameter (mm) & chain construction	No info	16 M/L chain	16 M/L chain	N/R	16 M/L chain	13 Chain	N/R	16 L/L chain	16 Chain	16 M/L chain	16 Chain

Table 5: Ground gear and adjuster chain assembly (Column 1 is standard rigging as per Manual for the International Bottom Trawl Surveys)

Wire rig	Standard	UK (Scotland) North Sea	UK (Scotland) W of S & Rockall	UK (England)	France	Germany	Norway	Sweden	Denmark	Netherlands	Ireland
Warp diameter (mm)	No info	28		26	22	28	N/R	20	20	28	26
Upper backstrop – Length (m) Diameter (mm) Material	Included in sweep length	**4.57** 16 L/L chain		**3.05** 16 Chain	**3.12** 16 Chain	**3.0** 24 Wire	**3.1** N/R wire	N/A	N/R	**3.0** 16 L/L chain	**3.0** 19 L/L chain
Lower backstrop – Length (m) Diameter (mm) Material	Included in sweep length	**4.57** 16 L/L chain		**3.05** 16 Chain	**3.12** 16 Chain	**3.2** 24 Wire	**3.1** N/R wire	N/A	N/R	**3.0** 16 L/L chain	**3.0** 19 L/L chain
Middle backstrop - Length (m) Diameter (mm) Material	Included in sweep length	**N/A**		**N/A**	**N/A**	**N/A**	**4.5** N/R wire	**N/A**	N/A	**N/A**	**N/A**
Backstrop extension – Length (m) Diameter (mm) Material	Included in sweep length	**8.53** 20 Wire		**6.71** 16 Chain	**9.1** 22 Chain	**6.5** 26 Wire	12 N/R wire	**13** 28 Combi	N/R	**10** 20 L/L chain	**4.0** 19 L/L chain
Short sweep – Length (m) Diameter (mm) Material	*Max 60 22 Wire	**47** 26 Wire		**50** 22 Wire	**50** 22 Wire	**50** 22 Wire	**50** 22 Wire	**49.4** 22 Combi	**60** N/R N/R	**50** 26 Wire	**55** 26 Wire
Long sweep - used (Y/N)	Y	N	Y	N	Y	N	Y	N	Y Q1 only	N	Y
If Y - Depth change made (m)	>70	N/A	>80	N/A	>120	N/A	>70	N/A	>70	N/A	>80
Long sweep – Length (m) Diameter (mm) Material	*Max 110 22 Wire	N/A	**97** 26 Wire	N/A	**100** 22 Wire	N/A	100 22 Wire	N/A	**110** N/R N/R	N/A	**110** 26 Wire
Length of connectors/swivel -between sweep and bridles (m)	No info	**0.59**		N/R	0.472	N/R	0.45	**1.1**	N/R	N/R	**2.0**
Lower bridle – Length (m) Diameter (mm) Material	38 20 Wire	**38** 20 Wire		**38** 22 Wire	**38** 20 Wire	**38.3** 22 Wire	**38.6** 20 Wire	**40.3** 14 (50) Rub-leg	**38.2** 20 Wire	**38** 20 Wire	**38** 22 Wire
Upper bridle 1st section – Length (m) Diameter (mm) Material	20 14 Wire	**20** 14 wire		**20** 16 Wire	**20** 14 Wire	**20.1** 14 Wire	**20** 14 Wire	**20** 20 Combi	**20** 14 Wire	**20** 14 Wire	**20** 16 Wire
Upper bridle 2nd section – Length (m) Diameter (mm) Material	20 14 Wire	**20** 14 Wire		**20** 16 Wire	**20** 14 Wire	**20.1** 14 Wire	**20** 14 Wire	**20** 20 Combi	**20** 14 Wire	**20** 14 Wire	**20** 16 Wire
Middle bridle – Length (m) Diameter (mm) Material	20 14 Wire	**20** 14 Wire		**20** 16 Wire	**20** 14 Wire	**20.1** 14 Wire	**20** 14 Wire	**20** 20 Combi	**20** 14 Wire	**20** 14 Wire	**20** 16 Wire
Length of connectors/swivel – between 1st upper bridle & mid/2nd upper bridles (m).	No info	**0.38**		N/R	0.01	N/R	**0.35**	**0.05**	N/R	N/R	**0.322**

*Note – Standard manual specifies sweep length + backstrop + backstrop extension length should total 60m (short) or 110m (long) overall.

Table 6: Wire rig (Column 1 is standard rigging as per Manual for the International Bottom Trawl Surveys)

Intercalibration of research survey vessels: "GWEN DREZ" and "THALASSA"

March 2015

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Contents

I) Context of the study

I.1) CGFS survey and need for intercalibration

The Channel Ground Fish Survey (CGFS) has been carried out on the R/V Gwen Drez annually in October since 1988 in the eastern English Channel. This bottom trawl survey provides information on the demersal community used for stock assessment, and more precisely indices for plaice, red mullet, sea bass, cuttlefish, but also biological parameters relative to age and size structure as well as maturity for several other species (dab, lemon sole, gurnards, pouting, turbot, brill). From 2015 onwards, the R/V Gwen Drez is reformed and can no longer be used, thus the CGFS survey will be carried out on another scientific vessel, the R/V Thalassa. In order to ensure a continuity of time series, if possible, an intercalibration between both vessels has been realized in October 2014.

I.2) Sampling design

The inter-calibration survey was based on paired hauls at selected sampling sites as recommended by numerous authors (e.g. Pelletier 1998; Wilderbuer et al. 1998). 32 sampling sites (see Figure 1) were selected based on catch rates information available from the CGFS time series since 1988. Site selection was based on a 3-step procedure:

1. identify species with an average frequency of occurrence in the survey area above 10% during the last 10 years;
2. among these species, select those that are (i) subject to European monitoring, (ii) well captured by the GOV trawl, and (iii) ecologically and economically important;
3. identify a few geographical areas were the selected species are found at high abundance and the specific composition of capture relatively similar between sampling sites using hierarchical agglomerative clustering on the abundance of selected species.

Given that no single geographical area combined all selected species, two complementary areas in terms of specific composition of the catch were identified with 16 sampling sites each (Figure 1): the bay of Seine (red) and the central English Channel (green).

Pairs haul were carried out at each sampling site with the two vessels towing simultaneously during 30 min at the same speed and as closely as possible (average distance between vessels around 300m). Because the two GOV gears differ in their opening width, catch data were standardized to trawled-surface unit before statistical analyzes (CPUE, in number of individuals per km^2) using the distance between shooting and hauling positions and the wing spread measured during each tow.

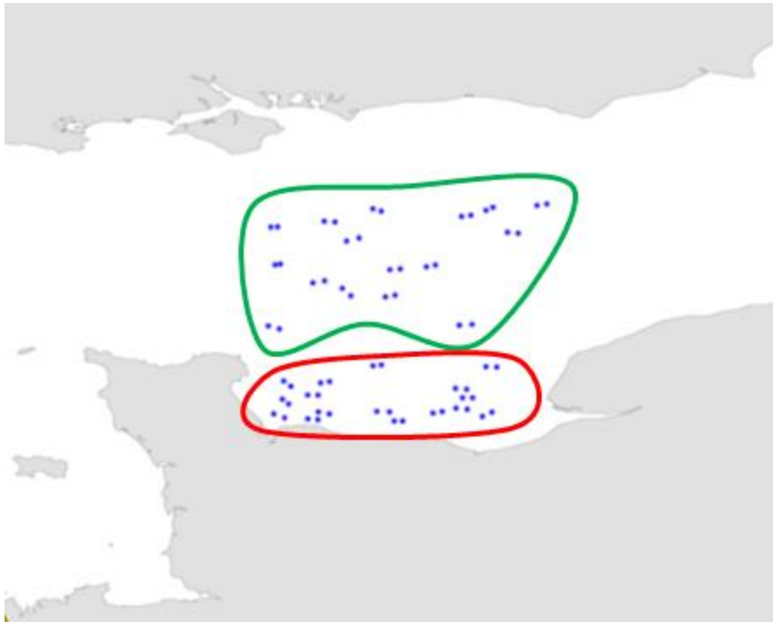

Figure 1. Spatial distribution of the 32 sampling sites (paired hauls) during the inter-calibration survey and identification of the two complementary areas in terms of specific composition of the fish community.

I.3) Gears characteristics and measured geometry

On the R/V Gwen Drez, a 19.7/25.9 GOV is deployed, with groundrope composed of rubber discs of 110mm of diameter, 6 bobins of 250mm in the square (bosom section of 5.90m), and 2 bobins of 150 and 2 bobins of 200mm in the quarter section. The trawl shows an average vertical opening of 3.21m, and an average wing spread of 10.34m which increases with increasing depth (Figure 2).

On the R/V Thalassa, a 36/47 GOV is deployed, similar to the gear used during the EVHOE survey, with groundrope composed of rubber discs of 110mm of diameter, bobins of 400mm in the square (bosom section of 5m), and bobins of 300mm and 400mm in the quarter section. The trawl shows an average vertical opening of 4.35m, and an average wing spread of 15 (Figure 3)

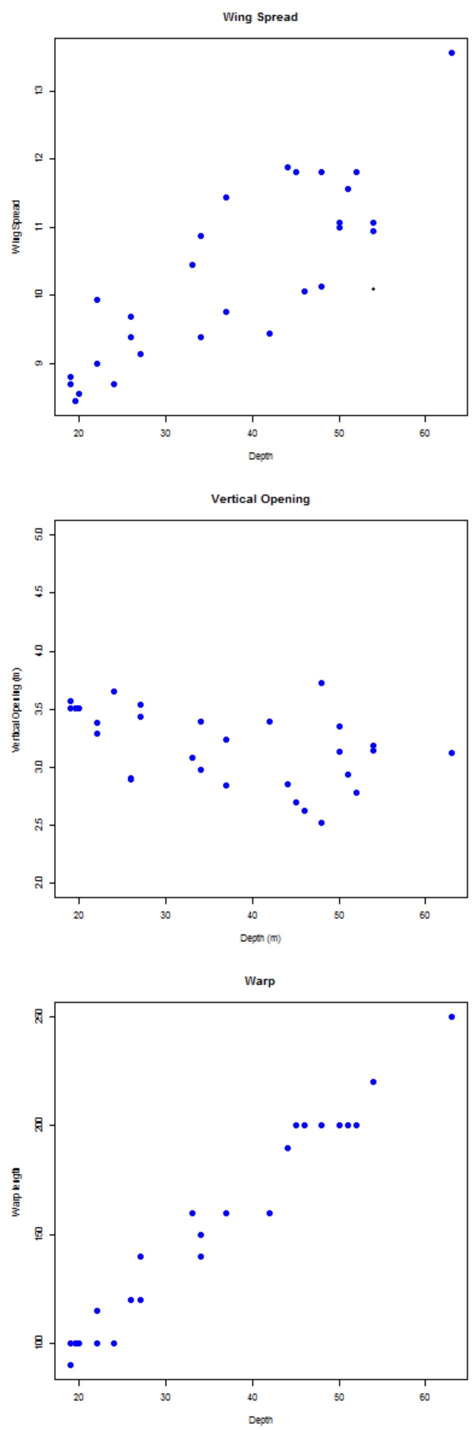

Figure 2. Measurements of trawl geometry on the R/V Gwen Drez using SCANMAR sensors: wing spread (top), vertical opening (middle) and warp length (bottom) with depth.

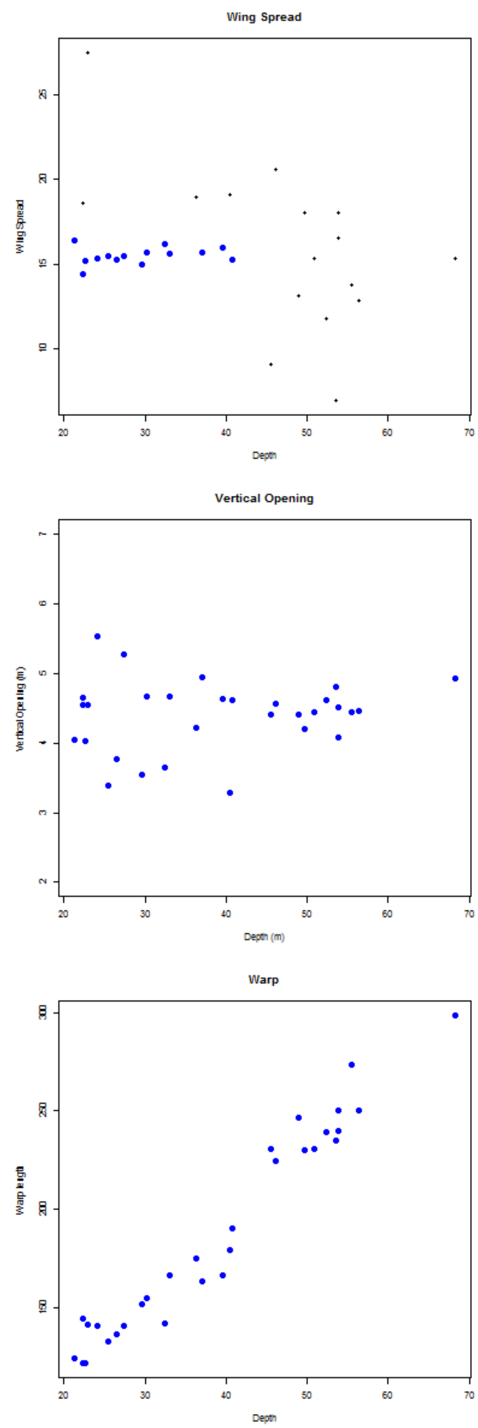

Figure 3. Measurements of trawl geometry on the R/V Thalassa using MARPORT sensors: wing spread (top), vertical opening (middle) and warp length (bottom) with depth. Note that the sensors recording wing spread produced some erroneous values (small dots).

II) Fish population-level analyses

II.1) Testing for difference in species' CPUEs

II.1.1) Methods

For each species, sampling sites for which the two vessels captured no individual were excluded from the analyses. Indeed, the simultaneous absence of a species (so-called 'double zeros') in the two vessels' catches at a given sampling site is uninformative about CPUE similarity (Legendre and Legendre 2012). The inclusion of double zeros in the analyses may thus lead to erroneous conclusions about vessels' catch similarity and consequently on correction coefficients.

Because of the large numbers of zeros (even when removing double zeros), CPUE data did not conform to the normality and homoscedasticity assumptions required to perform paired Student's t test nor was any transformation able to solve this problem. Therefore, CPUE data of each species were compared between vessels by a paired permutation test. The identity of vessels was switched at each sampling site (hence the paired aspect of the permutation) either so as to produce the 2^n possible permutations when the number of paired hauls n was below 10 or randomly 1000 times when $n > 10$. The average difference between vessels' CPUE across sampling sites was computed for each permutation to produce its distribution under the null hypothesis of similar vessels' catches. The quantile of the null distribution corresponding to the observed average CPUE was then taken as the probability p of a significant difference between vessels' CPUEs.

Because of multiple testing (same comparison test carried out for each species), the familywise type 1 error rate α_{F} is increased to a level that varies according to the dependence between tests with a maximum in case of total independence of $\alpha_{\mathrm{F,max}}(k) = 1-(1-0.05)^k$ where k is the number of tests, i.e., the number species in our case. A second series of p-values, p_{cor}, accounting for multiple comparisons was therefore computed using two nested permutation tests based on the max-statistic method (Groppe et al. 2011). The identity of vessels was again switched at each sampling (in the same way as above) but while keeping the original species composition of the catch (outer permutation). This randomized any potential association between the CPUE of each species and vessel while preserving any correlative structure between species CPUEs themselves. The first permutation test described above was then performed on each species' CPUE in the permuted dataset (inner permutation) and the minimum p value across species was recorded. This procedure was repeated 1000 times and the resulting distribution of minimum p values was used as the empirical null distribution against which observed p values computed through the first permutation test on the real CPUE dataset were tested. For each species, p_{cor} was taken as the quantile in the empirical null distribution of minimum p values corresponding to the observed p value.

The minimum number of non-double-zero paired hauls $n_{\min}$ required to perform CPUE comparison tests was defined as follows. p_{cor} was computed for each species with an increasing minimum number of non-double-zero paired hauls starting at 3. $n_{\min}$ was set at the value for which p_{cor} stabilized for all species. All species having less than $n_{\min}$ non-double-zero paired hauls were excluded from the analyses and correction coefficient computation.

II.1.2) Results

The stability analysis of p_{cor} values revealed that a minimum of $n_{\min} = 9$ paired hauls was required to perform CPUE comparisons between the two vessels.

For most captured species (43/65; 66%) during the intercalibration survey, CPUE comparison tests could not be carried out because of a number of non-double-zero paired hauls inferior to $n_{\min}$ (see 'NA' items in Table 1). Only 22 species were considered for statistical tests (see their names and CPUEs in Figure 2). However, these species represent 80% of the total abundance of all fish collected during the whole CGFS time series (i.e., since 1988) (Table 1).

According to simple permutation tests (uncorrected p-values p), the CPUE of 9 species (*Callionymus lyra*, *Chelidonichthys cuculus*, *Dicentrarchus labrax*, *Loligo forbesi*, *Raja clavata*, *Sardina pilchardus*, *Scomber scombrus*, *Scyliorhinus canicula*, *Trachurus trachurus*) was significantly different between the two vessels (Table 1) and thus, required the computation of a correction coefficient (see red arrows in Figure 4).

According to nested permutation tests (corrected p-values p_{cor}), the CPUE of 6 species (*Callionymus lyra*, *Chelidonichthys cuculus*, *Dicentrarchus labrax*, *Loligo forbesi*, *Sardina pilchardus*, *Scomber scombrus*) was significantly different between the two vessels (Table 1).

In order to be as conservative as possible, the computation of a correction coefficient was performed for each of the 9 species listed above.

II.2) Correction coefficients

II.2.1) Methods

Following Pelletier et al. (1998) and Wilderbuer et al. (1998), the correction coefficient of each species was estimated as the ratio of the mean CPUE of the 'Gwen Drez' vessel to the mean CPUE of the 'Thalassa' vessel, which is equivalent to taking the ratio between the total CPUEs of the two vessels:

$$\hat{R} = \frac{\sum_{j=1}^{n} Y_j}{\sum_{j=1}^{n} X_j} \qquad (1)$$

$\hat{R}$ is the ratio estimate or correction coefficient, *n* is the number of haul pairs, *j* indexes haul pairs, Y_j is the CPUE of the considered species from the *j*th haul by the 'Gwen Drez' vessel, and X_j is the CPUE of the same species from the corresponding haul by the 'Thalassa' vessel.

The 95% confidence intervals of the correction coefficients were calculated based on their variance computed according to the equation given by Cochran (1977) (in Wilderbuer et al., 1998):

$$Var(\hat{R}) = \frac{\dfrac{\sum_{j=1}^{n} (Yj - \hat{R}Xj)^2}{n-1}}{n\bar{X}^2} \qquad (2)$$

where $\hat{R}$, *n*, *j*, Y_j, and X_j are defined as in equation (1), and $\bar{X}$ is the mean CPUE of the considered species across all hauls by the 'Thalassa' vessel.

II.2.2) Results

According to correction coefficients (Table 1), the difference of CPUE between vessels was particularly important for (in decreasing order): *Callionymus lyra* (7.055 ± 0.647), *Chelidonichthys cuculus* (3.502 ± 0.574), *Raja clavata* (2.541 ± 0.296), *Scyliorhinus canicula* (2.537 ± 0.460), *Dicentrarchus labrax* (1.707 ± 0.091), *Loligo forbesi* (0.491 ± 0.009), *Trachurus trachurus* (0.389 ± 0.015), *Scomber scombrus* (0.127 ± 0.002) and *Sardina pilchardus* (0.056 ± 0.002). In contrast, based on permutation tests (see section II.1.2) 13 species did not necessitate correction and their coefficient was set equal to 1 (Table 1).

Table 1. Correction coefficient values, standard errors and 95% confidence intervals. 'NA' items correspond to species for which statistical tests could not be performed. Green cells correspond to significant difference of density means between vessels.

Species	Rubbin code		Correction coefficient	Standard error	95% confidence interval	Relative abundance on the overall CGFS time serie (%)	Permutation test pvalues (uncorrected)	Permutation test pvalues (corrected)	Number of traits (which are not 'double-zero')	Number of traits where none individuals were collected by the 'Gwen Drez' vessel	Number of traits where none individuals were collected by the 'Thalassa' vessel
Agonus cataphractus	AGONCAT		NA	NA	NA	0.045	NA	NA	3	30	30
Alosa fallax	ALOSFAL		NA	NA	NA	0.003	NA	NA	3	32	29
Ammodytes tobianus	AMMOTOB		NA	NA	NA	0.008	NA	NA	1	31	31
Arnoglossus laterna	ARNOLAT		NA	NA	NA	0.003	NA	NA	1	31	32
Blennius ocellaris	BLENOCE		NA	NA	NA	0.000	NA	NA	4	29	31
Buglossidium luteum	BUGLLUT		NA	NA	NA	0.060	NA	NA	1	31	31
Callionymus lyra	CALMLYR		7.055	0.804	[6.251-7.859]	0.801	<0.001	0.049	15	18	18
Chelidonichthys cuculus	CHELCUC		3.502	0.758	[2.744-4.259]	0.817	<0.001	0.033	28	5	11
Trigla lucerna	CHELLUC		1	0	[1-1]	0.078	0.74	1	10	29	24
Chelon labrosus	CHEOLAB		NA	NA	NA	0.000	NA	NA	1	32	31
Ciliata mustela	CILIMUS		NA	NA	NA	0.001	NA	NA	1	32	31
Clupea harengus	CLUPHAR		NA	NA	NA	1.579	NA	NA	1	31	32
Conger conger	CONGCON		NA	NA	NA	0.002	NA	NA	4	29	31
Ctenolabrus rupestris	CTELRUP		NA	NA	NA	0.002	NA	NA	2	31	30
Dasyatis pastinaca	DASYPAS		NA	NA	NA	0.006	NA	NA	1	32	31
Dicentrarchus labrax	DICELAB		1.707	0.30166206	[1.405-2.009]	0.178	0.002	0.041	9	24	24
Trachinus vipera	ECITVIP		NA	NA	NA	0.231	NA	NA	5	29	28
Engraulis encrasicolus	ENGRENC		1	0	[1-1]	0.642	0.109	0.922	23	16	10
Gobiidae	FMGOBII		NA	NA	NA	0.062	NA	NA	2	30	31
Gadus morhua	GADUMOR		NA	NA	NA	0.194	NA	NA	5	29	29
Galeorhinus galeus	GALOGAL		1	0	[1-1]	0.026	0.789	1	10	26	24
Gobius niger	GOBINIG		NA	NA	NA	0.000	NA	NA	6	30	28
Hippocampus	HIPP		NA	NA	NA	0.000	NA	NA	1	32	31
Hyperoplus	HIPPHIP	FMAMMOD	NA	NA	NA	0.340	NA	NA	6	28	29
	HYPEIMM		NA	NA	NA		NA	NA	1	32	31
	HYPELAN		NA	NA	NA		NA	NA	6	28	28
Labrus bergylta	LABSBER		NA	NA	NA	0.001	NA	NA	2	31	30
Labrus mixtus	LABSMIX		NA	NA	NA	0.000	NA	NA	3	31	29
Lepadogaster lepadogaste	LEPALEP		NA	NA	NA	NA	NA	NA	1	31	32
Limanda limanda	LIMDLIM		NA	NA	NA	1.034	NA	NA	4	30	28
Liza aurata	LIZAAUR		NA	NA	NA	0.026	NA	NA	2	32	30
Loligo forbesi	LOLIFOR	LOLI	0.491	0.093	[0.398-0.584]	1.993	<0.001	0.049	23	15	10
Loligo vulgaris	LOLIVUL		1	0	[1-1]		0.312	1	32	3	0
Lophius piscatorius	LOPHPIS		NA	NA	NA	0.002	NA	NA	1	32	31
Melanogrammus aeglefinu	MELAAEG		NA	NA	NA	0.000	NA	NA	1	31	32
Merlanguis merlangus	MERNMER		NA	NA	NA	1.581	NA	NA	3	30	30
Microstomus kitt	MICTKIT		NA	NA	NA	0.166	NA	NA	3	30	30
Microchirus variegatus	MICUVAR		NA	NA	NA	0.012	NA	NA	3	31	30
Mullus surmuletus	MULLSUR		1	0	[1-1]	0.590	0.228	0.997	25	14	9
Mustelus	MUST		1	0	[1-1]	0.159	0.82	1	14	19	22
Pagellus erythrinus	PAGEERY		NA	NA	NA	0.000	NA	NA	5	28	30
Palaemon serratus	PALOSER		NA	NA	NA	0.027	NA	NA	1	32	31
Pleuronectes platessa	PLEUPLA		1	0	[1-1]	0.644	0.072	0.789	9	24	23
Raja brachyura	RAJABRA		NA	NA	NA	0.006	NA	NA	2	30	32
Raja clavata	RAJACLA		2.541	0.544	[1.997-3.085]	0.122	0.004	0.108	22	15	13
Raja undulata	RAJAUND		NA	NA	NA	0.008	NA	NA	8	29	26
Sardina pilchardus	SARDPIL		0.056	0.041	[0.015-0.097]	1.830	<0.001	0.033	22	23	10
Scomber scombrus	SCOMSCO		0.127	0.043	[0.084-0.17]	1.841	<0.001	0.033	28	23	4
Scophthalmus maximus	SCOPMAX		NA	NA	NA	NA	NA	NA	1	32	31
Scophthalmus rhombus	SCOPRHO		NA	NA	NA	0.007	NA	NA	4	29	31
Scyliorhinus canicula	SCYOCAN		2.537	0.678	[1.859-3.216]	1.536	0.003	0.085	27	7	9
Scyliorhinus stellaris	SCYOSTE		1	0	[1-1]	0.079	0.817	1	15	20	18
Sepia officinalis	SEPIOFF		1	0	[1-1]	0.277	0.467	1	22	16	14
Solea solea	SOLESOL		NA	NA	NA	0.117	NA	NA	4	30	28
Sparus aurata	SPARAUR		NA	NA	NA	0.001	NA	NA	2	32	30
Spondyliosoma cantharus	SPONCAN		1	0	[1-1]	1.545	0.204	0.995	29	11	4
Sprattus sprattus	SPRASPR		NA	NA	NA	7.533	NA	NA	2	30	31
Symphodus bailloni	SYMPBAI		NA	NA	NA	NA	NA	NA	2	30	32
Syngnathus acus	SYNGACU		NA	NA	NA	0.000	NA	NA	1	32	31
Trachurus trachurus	TRACTRA		0.389	0.121	[0.269-0.51]	37.655	0.003	0.085	32	0	0
Trachinus draco	TRAHDRA		NA	NA	NA	0.009	NA	NA	5	30	28
Trisopterus luscus	TRISLUS		1	0	[1-1]	5.437	0.221	0.997	13	22	23
Trisopterus minutus	TRISMIN		1	0	[1-1]	23.796	0.065	0.778	24	14	12
Zeugopterus punctatus	ZEUGPUN		NA	NA	NA	0.001	NA	NA	1	32	31
Zeus faber	ZEUSFAB		1	0	[1-1]	0.050	0.097	0.895	30	9	3

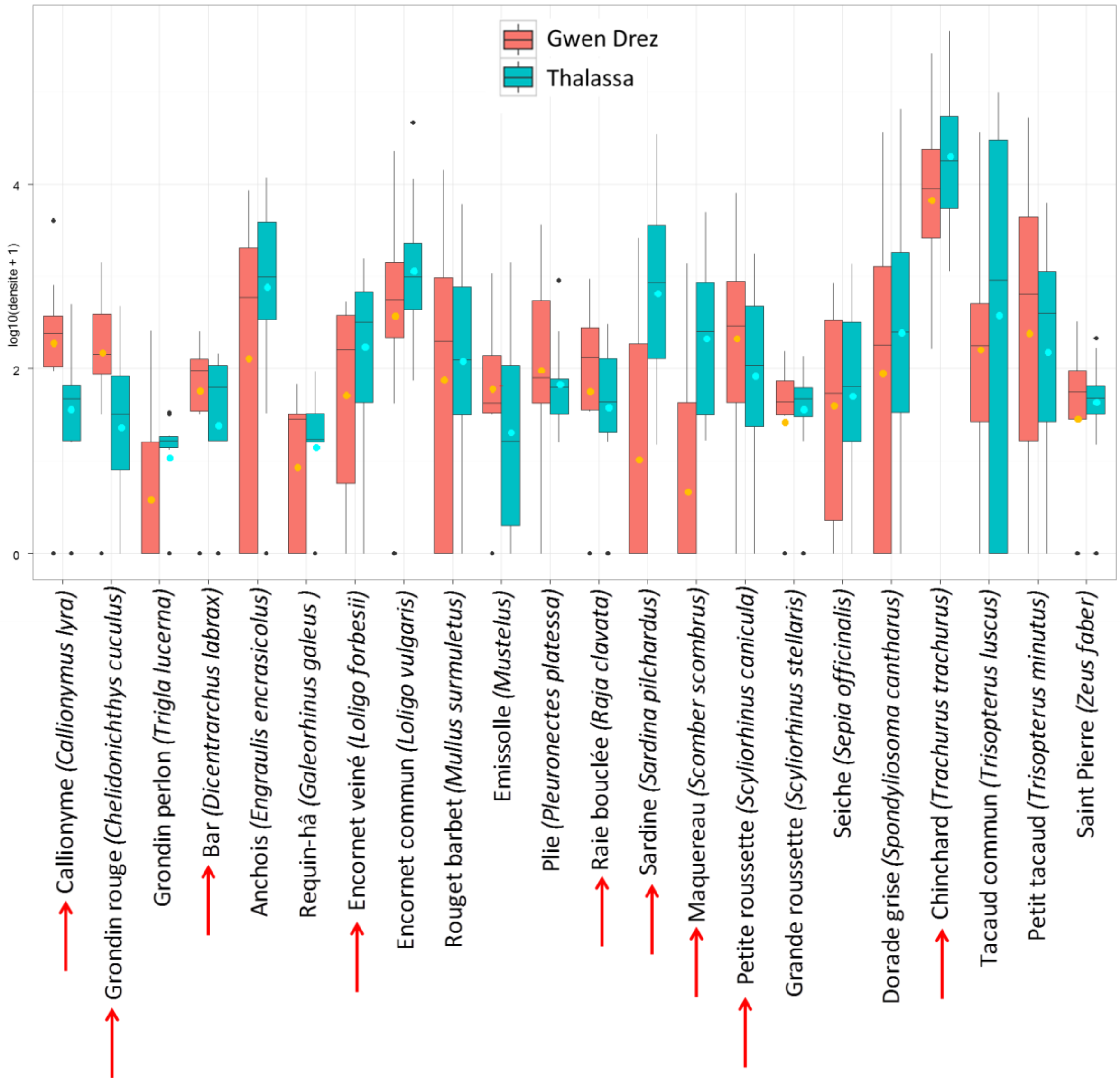

Figure 4. Boxplot representing log-transformed species CPUEs (nb. ind./km²) of the 'Gwen Drez' (red) and 'Thalassa' (blue) vessels. Only species for which the number of non-double-zero paired hauls is greater or equal to the minimum number of traits $n_{\min} = 9$, and thus for which statistical tests could be performed, are presented. Red arrows indicated species for which a correction is required according to simple permutation tests (uncorrected p-values p). Orange and blue circles correspond to the mean CPUE on 'Gwen Drez' and 'Thalassa', respectively. Horizontal lines within boxes give the median of the distribution, boxes' limits give the first and last quartile, whiskers extend to the most extreme data point which is no more than 1.5 times the interquartile range from the corresponding boxes, dots are data points outside the whiskers' limits.

III) Fish community-level analyses

III.1) Multivariate description of the data

In order to describe and compare the structure of communities captured by the two vessels, a non-metric Multidimensional Scaling (nmMDS) was first performed on the matrix of catch composition (CPUE organized by species as columns and by combinations of sampling sites and vessels as lines). Only species with CPUE representing more than 0.1% of the total CPUE were included in this analysis (Kortsch *et al.*, 2012).

According to the biplot of the nmMDS on its 2 first axes (Figure 5), the structure of communities collected by the 'Gwen Drez' vessel were relatively different to those collected by the 'Thalassa' vessel.

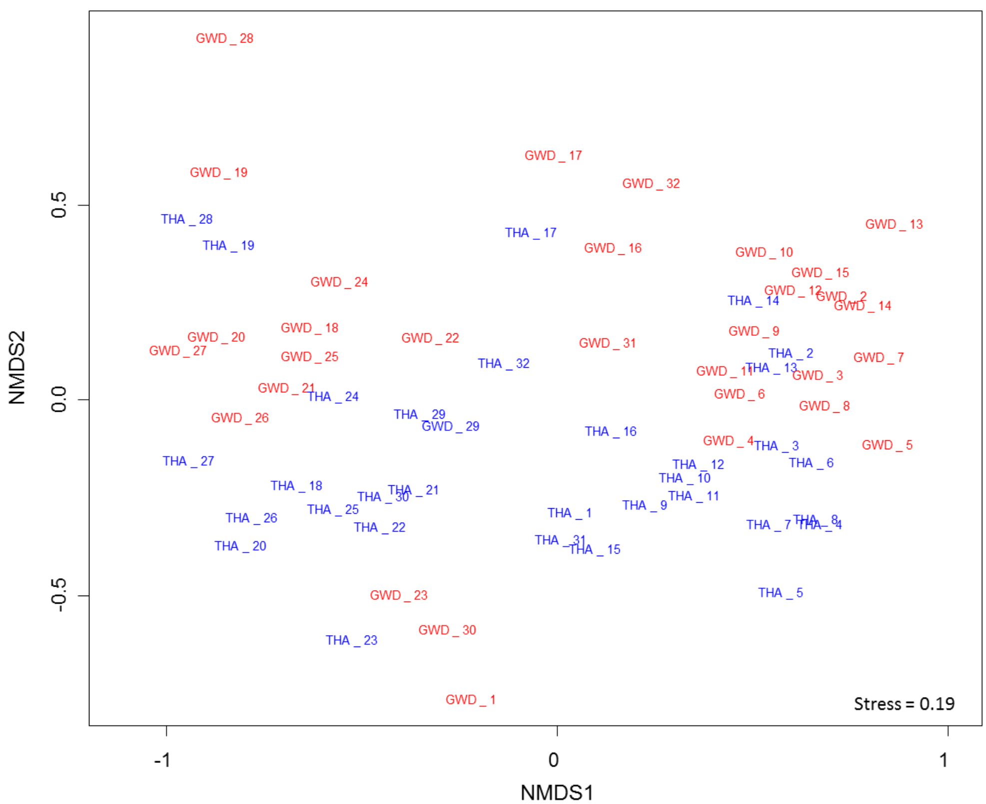

Figure 5. Non-metric Multidimensional Scaling biplot representing fish community structure collected by each vessel at each sampling site (graph items: 'Name of the vessel_site number'; 'GWD': 'Gwen Drez' in red, 'THA': 'Thalassa' in blue).

III.2) Testing for difference in community structure

Because of spatial variation in the structure of communities, the vessel effect on the composition of the catch was assessed by performing a ‘Partial Redundancy Analysis’ (pRDA) with the matrix of catch composition as explained matrix, the vector of vessel identity as explanatory variable, and the vector of sampling sites as condition variable in order to remove any spatial effect. The pRDA revealed a significant difference of community structure between the two vessels (p=0.012) based on post-pRDA permutation tests (Legendre & Legendre 2012).

In order to mimic the procedure used for species-level analyses, difference of community structure between the two vessels was also tested by performing a permuted-based paired Hotelling’s T^2 test. As for species-level analyses, the identity of vessels was switched randomly at each sampling 1000 times while keeping the original species composition of the catch. This randomized any potential association between catch composition and vessel. The T^2 statistics was then computed for the 1000 permuted datasets to obtain its empirical distribution under the null hypothesis of similar catch composition between the two vessels. The quantile of the null distribution corresponding to the observed T^2 statistic was then taken as the probability of a significant difference between vessels’ catch compositions. Only species with a number of non-double-zero paired hauls superior or equal to $n_{\min} = 9$ were considered in this test. The permutation-based paired Hotelling’s T^2 test detected a significant difference of community structure between the two vessels at a probability of 0.0483.

III.3) Assessing the efficiency of correction coefficients at community level

In order to assess the efficiency of correction coefficients at community level, a second pRDA was performed on the corrected catch composition matrix, i.e. after correcting Thalassa CPUEs according to correction coefficients, with the same model as in section III.2. After correction, no significant difference was detected between the two vessels (post-pRDA permutation test: p=0.408; Figure 6), which means that the proposed inter-calibration procedure allows assessing the Gwen Drez’s trawl contents from those collected on the ‘Thalassa’ vessel.

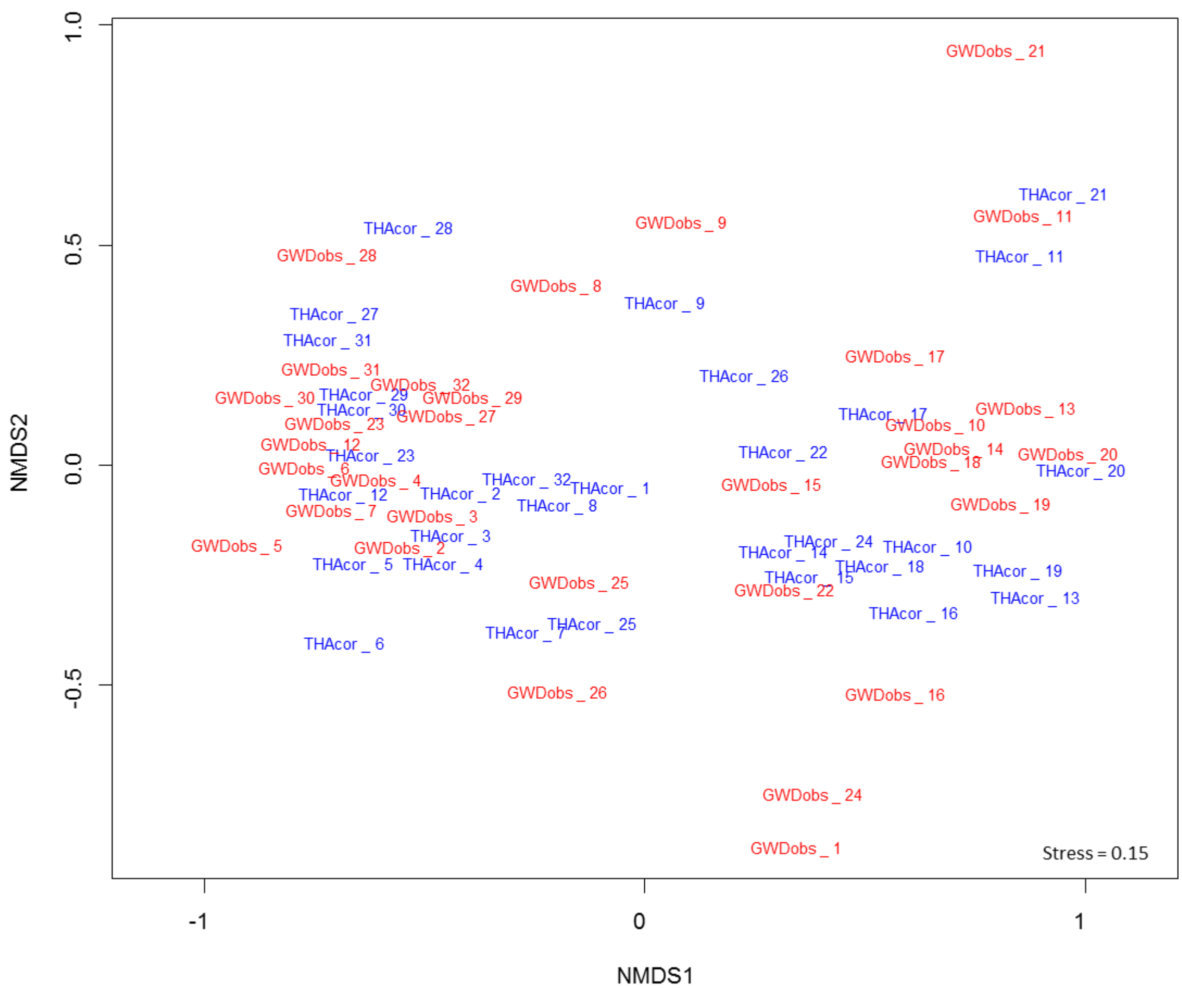

Figure 6. Non-metric Multidimensional Scaling biplot representing fish community structure collected by the 'Gwen Drez' vessel ('GWDobs' red items) and corrected fish community data of the 'Thalassa' vessel ('THAcor' blue items).

IV) Synthesis & Conclusions

Based on data collected during the inter-calibration survey conducted in October 2014, the CPUE of 22 species could be statistically compared between the vessels, the other species being too rarely caught to allow rigorous analysis. The CPUE of 9 species differed significantly between the two vessels and will therefore necessitate a correction for maintaining the CPUE time series (Figure 7). In contrast, the CPUE of 13 species did not differ significantly between vessels and thus do not require any correction (correction coefficient set equal to 1). Unfortunately, CPUE comparison tests could not be carried out for the 43 remaining rare fish species because of an insufficient number of paired hauls with at least one positive CPUE (too many 'double zeros'). Such comparison will have to be done at a more aggregated taxonomic level, for instance by grouping all gadoids, assuming a similar catchability between grouped species. However, the 22 species for which a comparison was possible represent most (80%) of total fish abundance collected across the whole Eastern English Channel on the overall CGFS period (i.e. since 1988). It is also important to note that CPUE of flatfish species and notably plaice does not significantly differ between both vessels, confirming that the two gears used during the intercalibration survey have a similar contact with the sea floor.

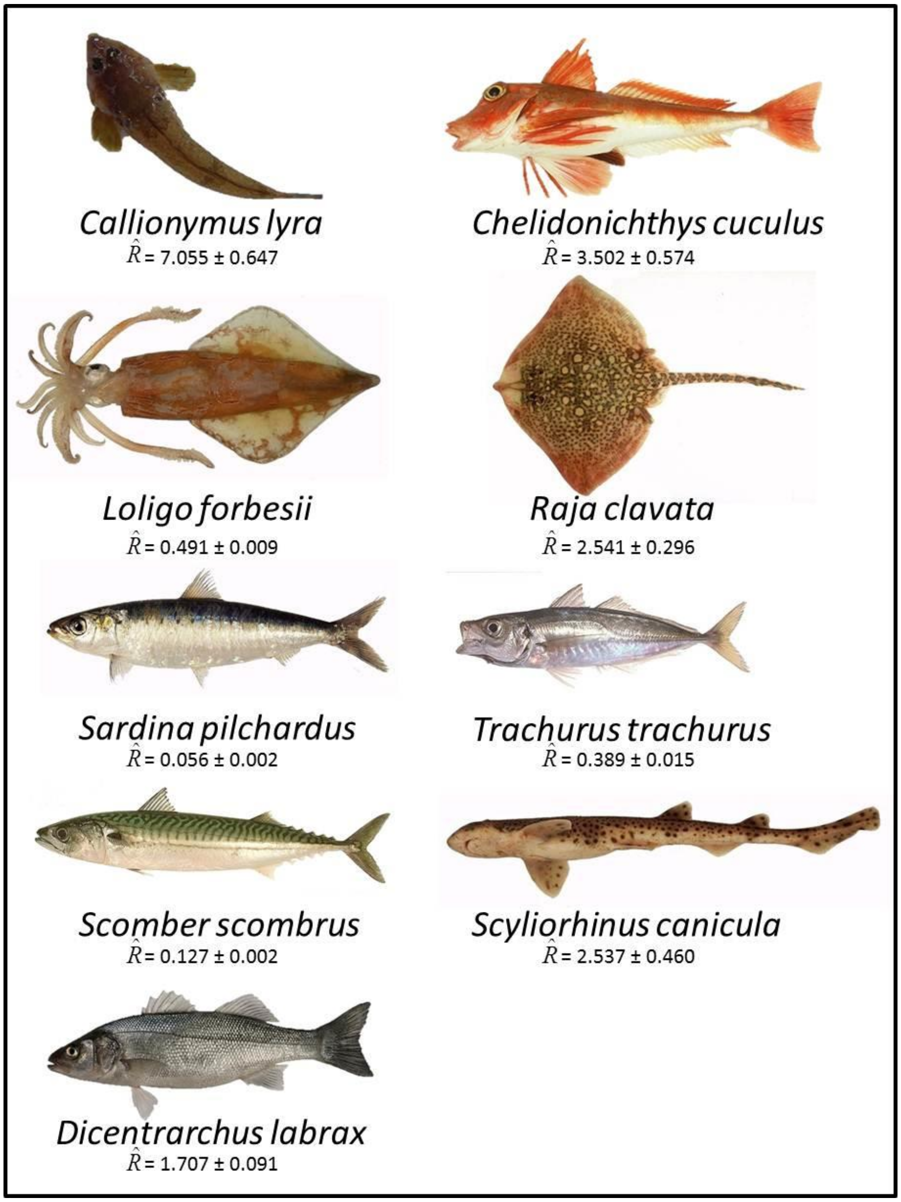

Figure 7. Pictures of the species for which a correction is needed and their respective correction coefficient.

At the community-level, statistical analyzes showed that the correction of CPUE values from the 'Thalassa' was both necessary and effective since it allowed an acceptable assessment of the community structure collected by the 'Gwen Drez' vessel. Concerning the values of the correction coefficients, for 4 species (sardine, horse mackerel, mackerel and veined squid), the R/V Thalassa catches significantly more individuals than the R/V Gwen Drez. It is worth noting that the former has a higher vertical opening (4.35m versus 3.21m) which typically allows for higher catch of these pelagic species. For the 5 other species requiring a correction coefficient, the R/V Thalassa catches less individuals than the R/V Gwen Drez.

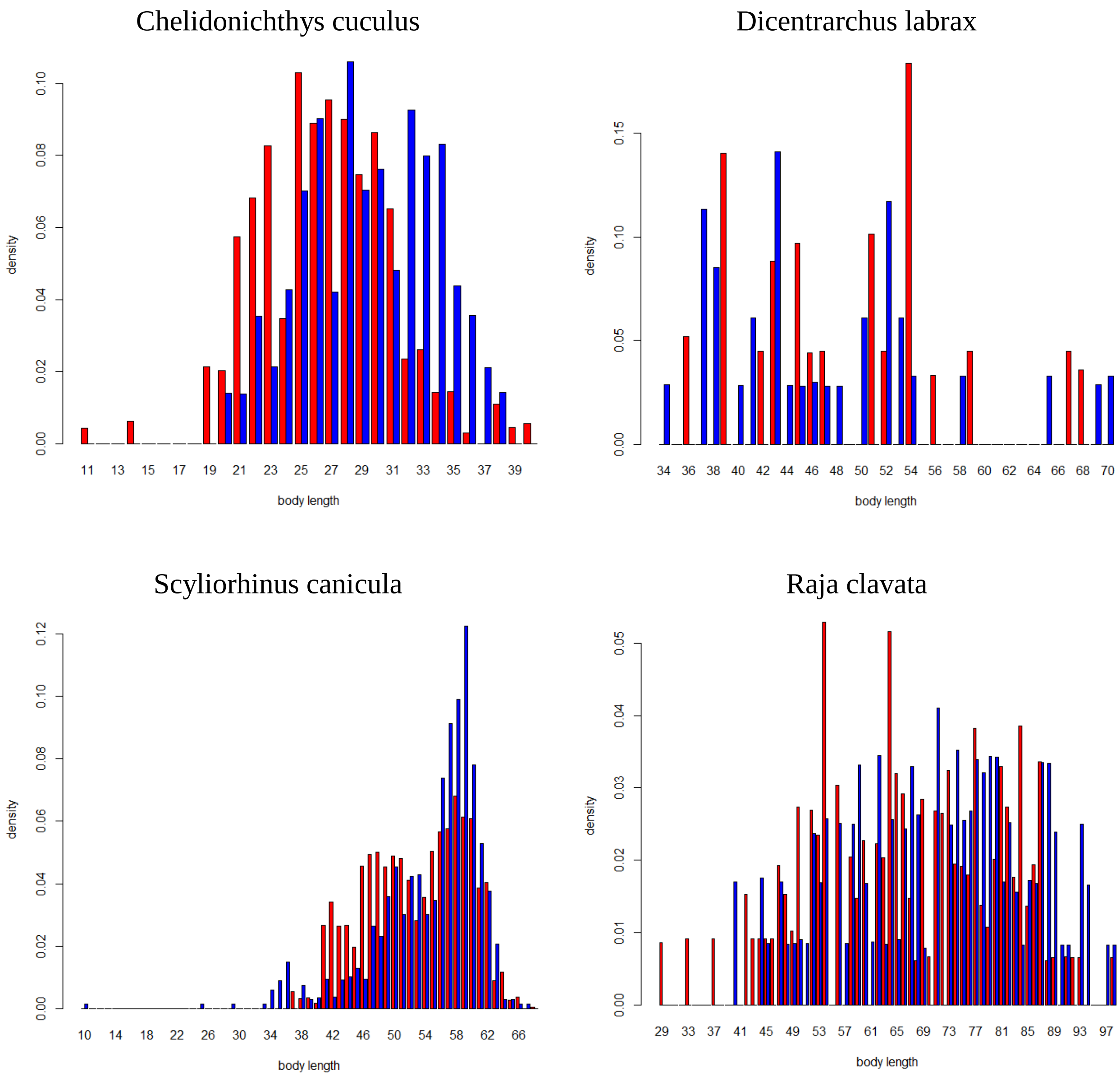

Figure 8. Comparison of size structures of the 4 species caught more on the R/V Gwen Drez than on the R/V Thalassa. The comparison cannot be made for dragonet as this species was not measured on R/V Gwen Drez. In red: relative size structure of species caught on the Gwen Drez, in blue: relative size structure of species caught on Thalassa.

While the size range sampled by each vessel is similar for these species (Figure 8), for *Chelidonichthys cuculus* there seem to be a higher proportion of large fish caught by the Thalassa compared to the Gwen Drez vessel. The size distribution is similar between the vessels for *Scyliorhinus canicula*, and for the 2 other species requiring correction coefficients (*Dicentrarchus labrax* and *Raja clavata*) the size distribution does not show any mode but does not seem to differ from one vessel to the other (Figure 8).

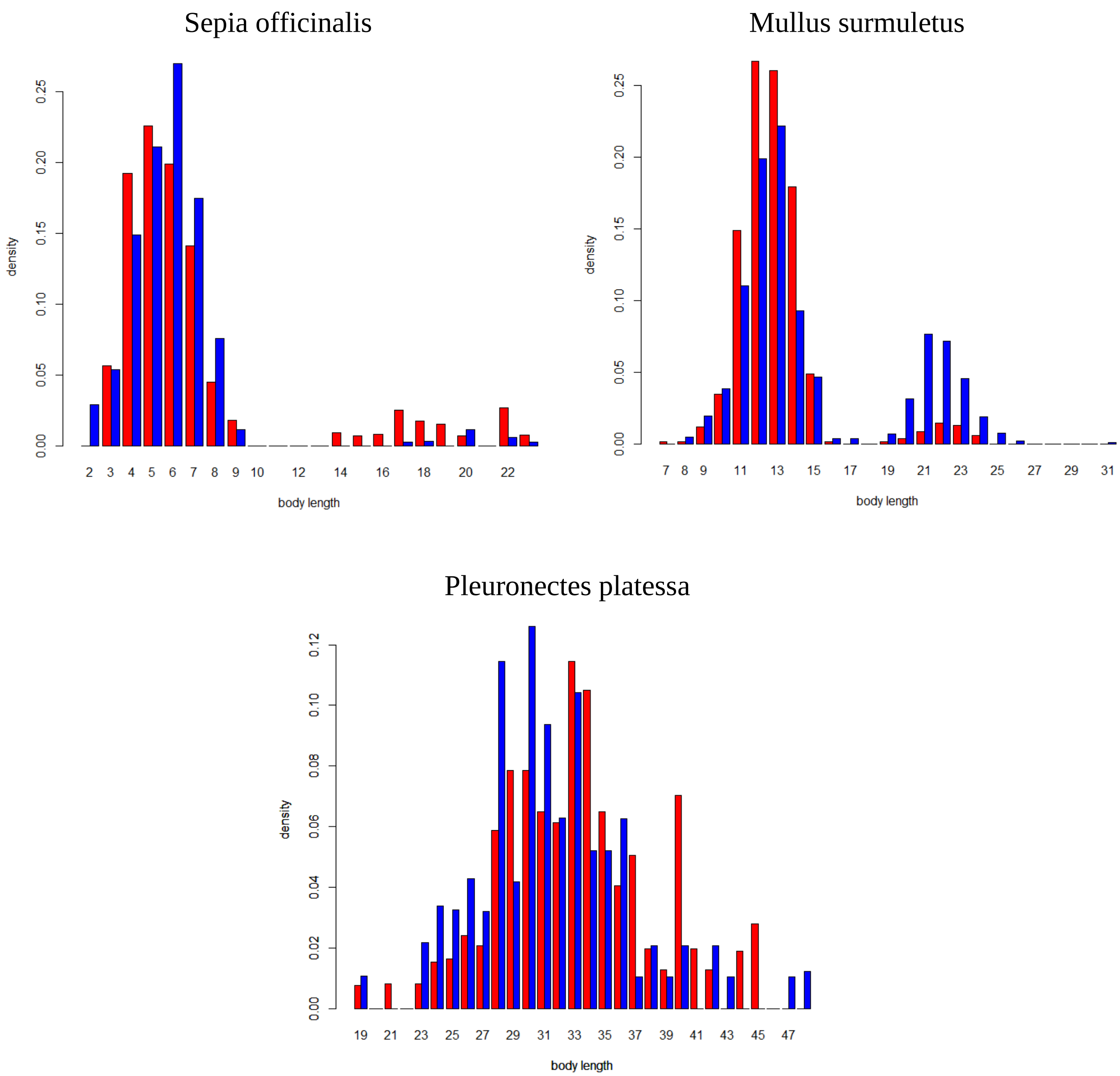

Figure 9. Comparison of size structures of the 3 species assessed base on CGFS species (the 4th species assessed, seabass, is represented on Figure 8). In red: relative size structure of species caught on the Gwen Drez, in blue: relative size structure of species caught on Thalassa.

It is important to note that for the stocks assessed using CGFS data (plaice, cuttlefish, red mullet and sea bass), the CPUE (except for sea bass) and size structure do not differ much between the vessels (Figure 9). Concerning red mullet (*Mullus surmuletus*), there might be more large fish caught by the Thalassa than by the Gwen Drez, but the bi-modal size distribution can be clearly derived from both vessels. For the flatfish plaice (*Pleuronectes platessa*), the size distribution appears to be identical between vessels.

In conclusion, the analysis of the catches realized by both vessels during paired tows shows qualitatively the same compositions of species and size structure, illustrating a similar behavior of the gears deployed. Furthermore, after comparison of the CPUE of the 22 non rare fish species, 13 species show no differences of CPUE between Thalassa and Gwen Drez, and time series regarding their abundance and biomass can be continue using the R/V Thalassa from 2015 onwards. For the 9 remaining species, the difference of CPUE has been quantified, so the time series can continue assuming a correction using the coefficients determined in the present study. The analysis of the community structure using the corrected CPUE when needed clearly illustrates the usefulness of using such correction coefficients, and will allow a continuity of analyses regarding community dynamics as well.

V) References

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Sampling for age data: A 'quick and dirty' analysis on the options for more efficient sampling

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1. Issues

In Section 10 of the 2015 IBTSWG report, 'Survey Design', the discussion of IBTSWG 2015 is presented, were strong arguments have been brought forward to move from the current method of collecting otoliths for age data to a station-specific sampling scheme (compare Aanes and Vølstad, in press). This discussion was brought on the table because the overall feeling is that the number of otoliths per species collected is higher than required to gain similar certainty around the ALKs structured based on these otoliths. Furthermore, discussion on the number of otoliths collected arise because:

- Experimental Animal Laws in some countries require the reduction or better justification of the number of fish harmed for collected these otoliths.
- Additional activities are wished for, while time on board is limited.
- Financial aspects related to handling, preparing and age reading the otoliths back in the lab.

The discussion triggered some quick and dirty analysis on in the first place whiting. The analysis focussed on showing the current number of otoliths collected and the effect of reducing these numbers on estimating the ALK and with that the numbers at age. It were quick and dirty analysis just to indicate if a reduction of otoliths might actually be feasible.

2. Data

- IBTS Q3 2014
  - Whiting otoliths: 4700
  - Haddock : 3861
  - Norway Pout: 1545
- Total collected by Scotland:
  - Whiting otoliths: 1402
  - Haddock : 1335
  - Norway Pout: 557
- Only roundfish area 1:
  - Whiting: 1243
  - Haddock: 1615
  - Norway Pout: 901
- Roundfish area 1 by Scotland
  - Whiting: 397
  - Haddock: 579
  - Norway Pout: 262

The focus on Scotland is because the already decided to collect their otoliths by sampling station, rather than by roundfish area (which is the current design). The ALK's are produced by roundfish area (borrowing from neighboring areas if necessary), therefore the focus was on the effect of reducing the number of otoliths on the ALK estimated for a single roundfish area. As the first focus was on whiting and on Scottish data, the choice for round fish area 1 is clear. As this area is fully covered by Scotland and whiting is present nearly everywhere.

The raw ALK from the datras products for whiting in 2014 Q3 in RF1 (1 otolith for age-8 and 0 for age-9 and 2 for age-10) indicates a distinct age-0 group (Fig. 1) and overlap occurs from a length of 23 cm. It also shows that a large number of otoliths is collected below the length of 15 cm, which are actually all age-0. Checking multiple years indicates that is a very consistent pattern. This directly provides an indication that the number of otoliths below that length can be reduced to result in the same ALK with similar certainty.

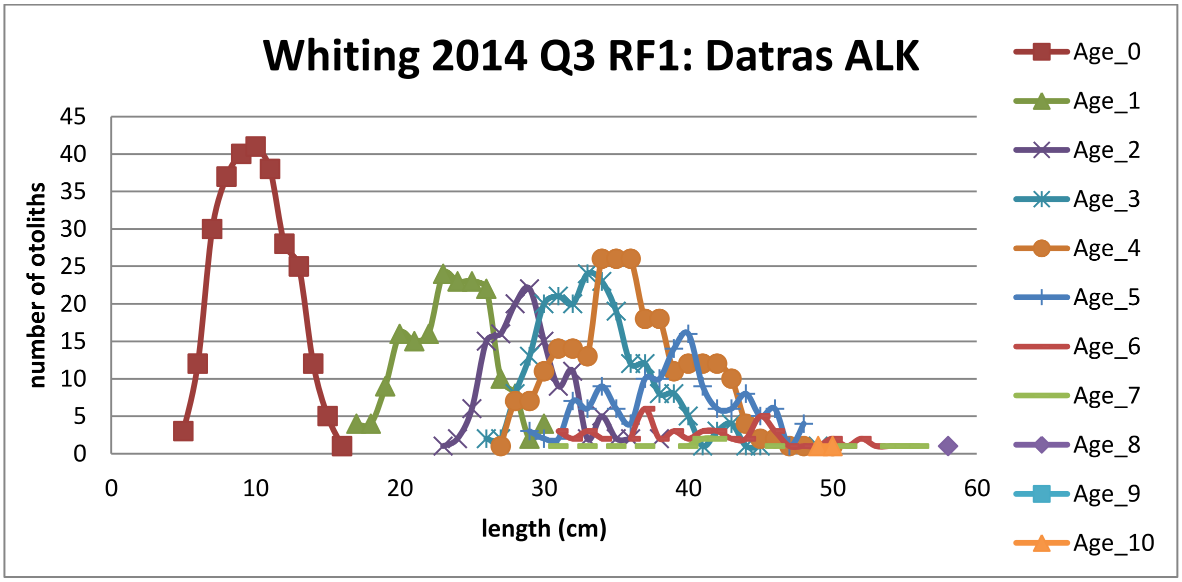


Figure 1: Visualisation of the numbers of otoliths by length of whiting in 2014 Q3 in roundfish area 1 as present in the downloadable datras ALK (20-4-2015).

3. Method

The age data (individual fish, with length (cm) and age (year) by sampling station) are used directly from the CA-file from Datras (21-4-2015). This data are used to fit the ALks using a multinomial logistic regression (R function multinom).

The ALKs are fitted for the total sets or subsets. Subsets are created by randomly selecting a specified number of otoliths by sampling station from the total number of otoliths within a length group. For whiting the length groups were 6-10,11-15,16-20,21-25,26-30 cm.

The results of the multinom-function are proportions at length and age (for the lengths for which otoliths were used in the function). The missing lengths are filled by smoother through the points. Than the proportions are multiplied by the total number of fish caught by length in the roundfish area based on the HL-files.

4. Results and discussion

Whiting

Figure 2 is the plot of the results of the multinom function based on the age data of whiting in roundfish area 1 from the CA file (1243 otoliths). Modelling the data rather than the raw numbers indicates overlap between age-0 and age-1 around a length of 15 and 16 cm. And a overlap between age-1 and age-2 around 20cm.

Using only the Scottish data from RF1 (Fig 3), thus only 1/3 of the total numbers (397 otoliths), results in nearly the same figure, only >30cm differences are visible. Indicating that when the whole length range is sampled reducing the number of otoliths by a third has no to limited effect on the ALK of whiting below 30cm. Taking this into account resulted in the selecting at random 1 otolith per 5 cm class (6-10,11-15,16-20,21-25,26-30 cm) per sampling station and no otoliths of 5cm or below and the regular sampling of 1 otolith per cm above 30cm. This results in a further reduction of otoliths from 397 to 237. The results for the modelled ALK are shown in Figure 4, indicating really minor changes in the estimates.

The small differences in ALK might still result in larger differences in the estimates of the number at age. In figure 5 the total number of whiting caught by all countries in roundfish area 1 is transformed based on the modelled ALK based on all the otoliths collected in RF1 (Fig 2). This figure can be compared to the same number of whiting but then transformed based on to subsets of the Scottish data (237 otoliths, Fig 6). The clearest difference is seen around length 13-15cm, where using the Scottish otoliths alone a part of the whiting is given Age-1.

This indicates that using only a subset of the Scottish data would actually be to limited. However, at least two countries will be fishing in this RF1 which would double the amount of otoliths. That would most likely be enough for estimating the ALK. When all the countries start collecting the otoliths by sampling station it would enable to estimate an ALK by sampling station and estimating the numbers at age even more precise than currently is the case by borrowing missing pieces from the ALK from neighbouring roundfish areas.

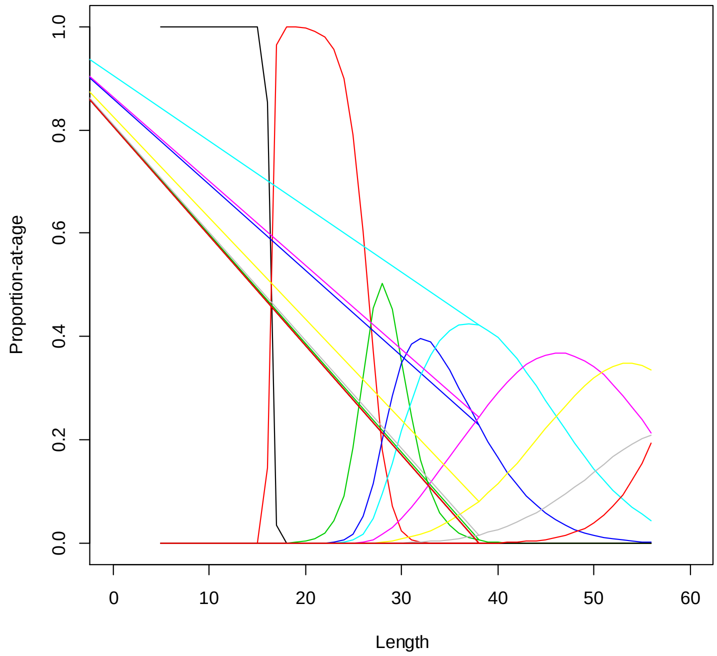


Figure 2: Multinomial fit of all the whiting otoliths in 2014 Q3 in roundfish area 1. Black(left side) = age-0, red = age-1, green=age-3, etc.

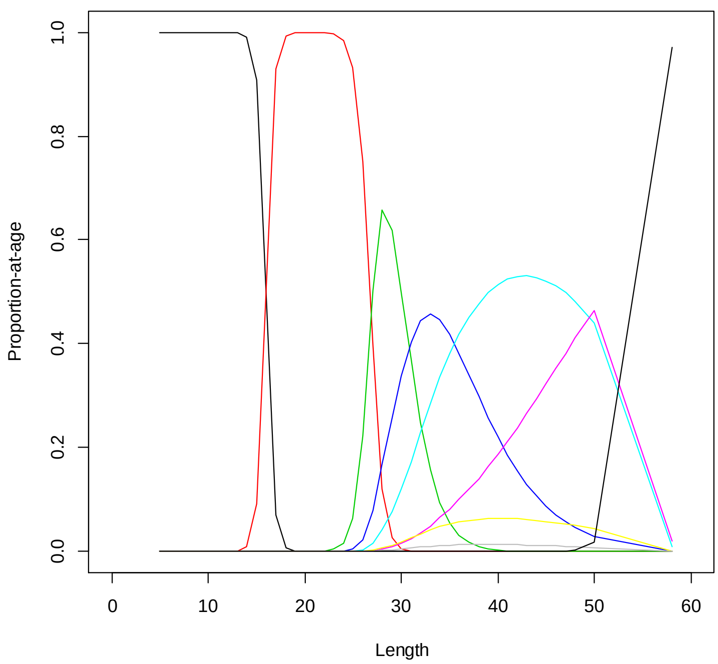


Figure 3: Multinomial fit of the Scottish whiting otoliths in 2014 Q3 in roundfish area 1. Black(left side) = age-0, red = age-1, green=age-3, etc.

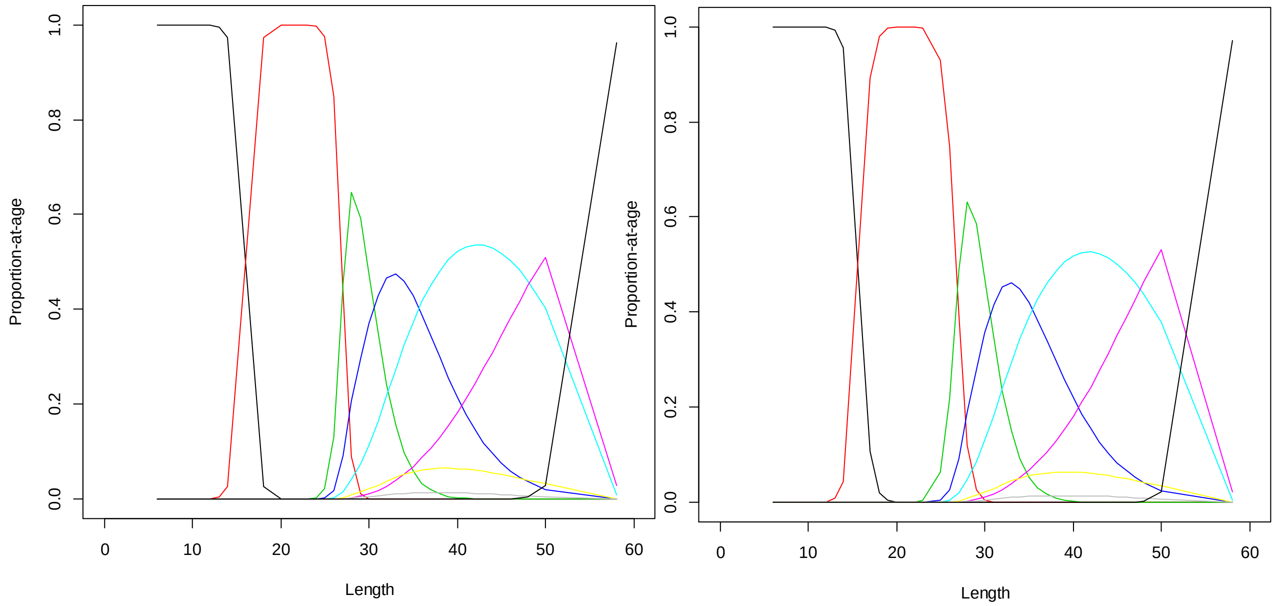


Figure 4: Two multinomial fits of the Scottish whiting otoliths in 2014 Q3 in roundfish area 1, selecting no otoliths of 5cm or smaller, 1 otolith per 5cm till 30cm and 1 otolith per 1cm above 30cm. Overlapping both figures would, while difficult to see, actually show that there is a small difference.

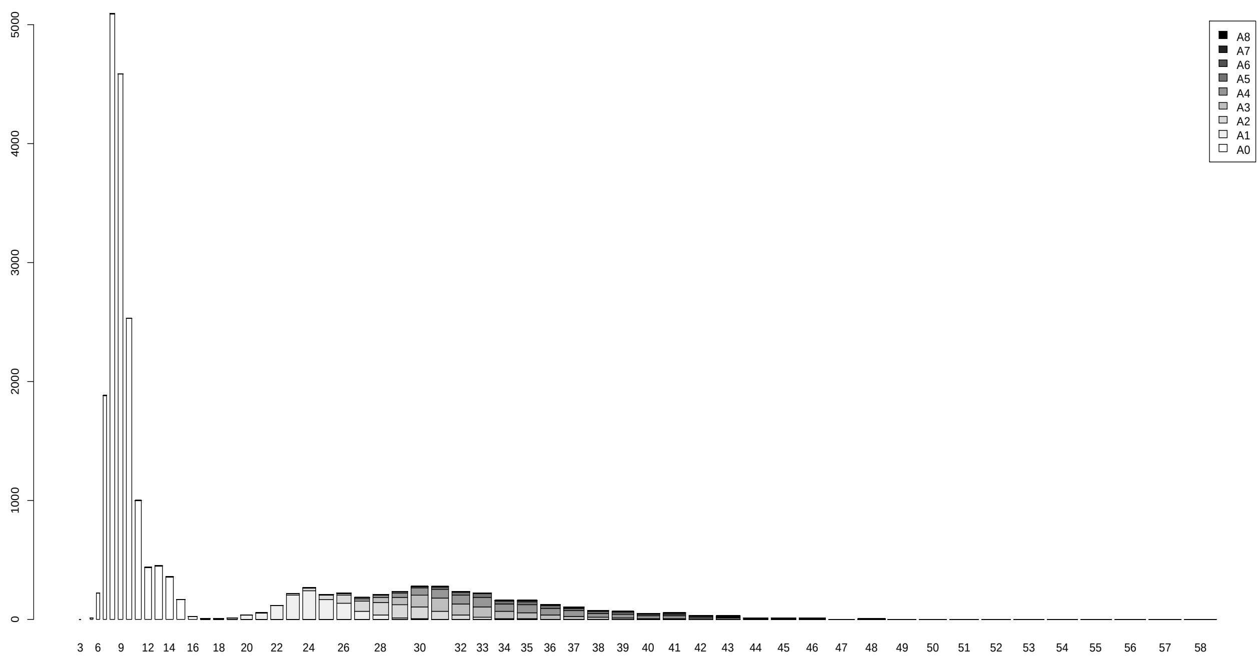
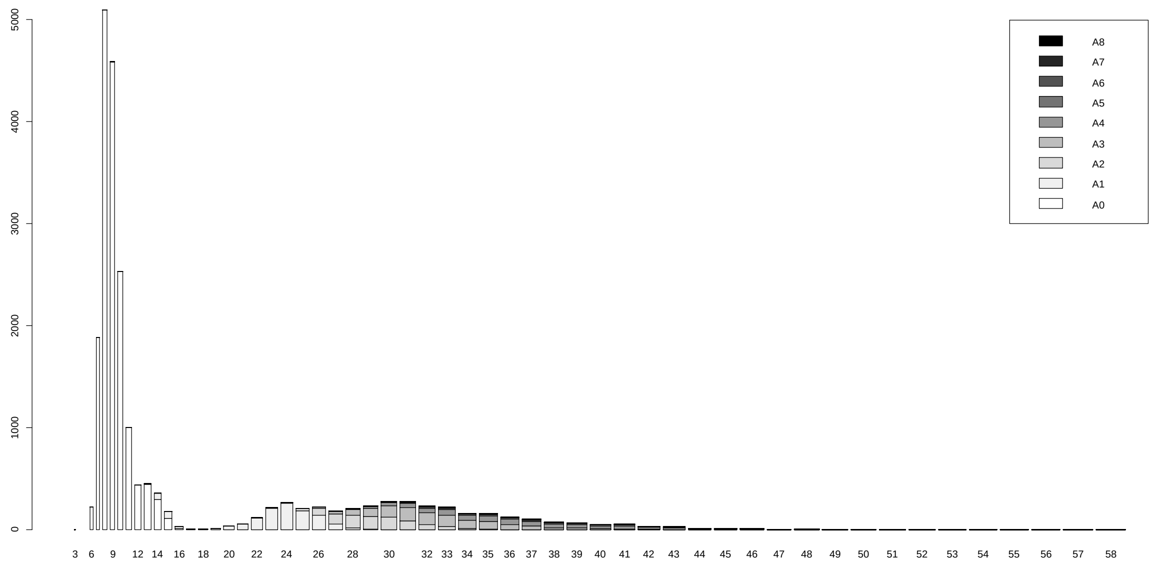


Figure 5: Total number of whiting caught in 2014 Q3 in RF1 by all countries, by age based on the complete ALK (1243 otoliths).



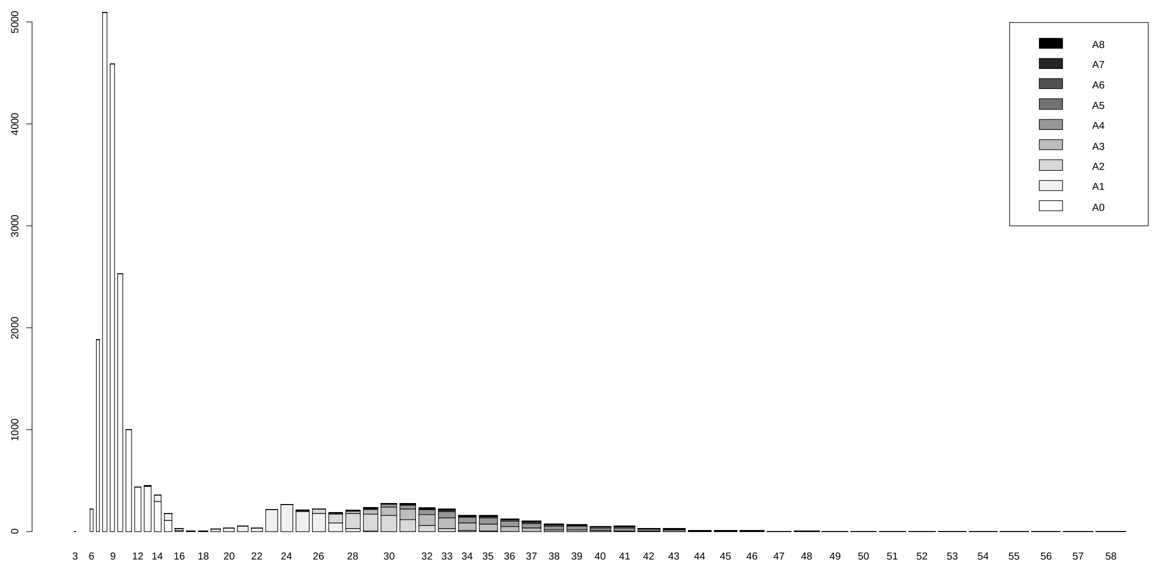


Figure 6.: Total number of whiting caught in 2014 Q3 in RF1 by all countries, by age based on two random sets of the smallest number of Scottish Otoliths (237).

Haddock

Figure 7 is the plot of the results of the multinom function based on the age data of haddock in roundfish area 1 from the CA file (1615 otoliths). Modelling the data rather than the raw numbers indicates overlap between age-0 and age-1 around a length of 17 and 18 cm. And a overlap between age-1 and age-2 around 21 cm.

Making a subset of the Scottish haddock data from RF1 by selecting at random 1 otolith per 5 cm class (6-10,11-15,16-20,21-25,26-30 cm) per sampling station and no otoliths of 5cm or below and the regular sampling of 1 otolith per cm above 30cm results in 406 otoliths (instead of 579). The results for the modelled ALKs are shown in Figure 8, indicating really minor changes in the estimates. As only 1 otolith in the 5 cm group 6-10 and 11-15 are selected it depends a bit where the downward line for age-0 and upward line for age-1 starts. However looking at the total numbers of haddock caught in roundfish area (Fig 9) it is clear that fish of this length class are not caught in Q3. The difference in ALK for age-0 and age-1 has therefore only a very small effect on the estimates of age at length (Fig 10).

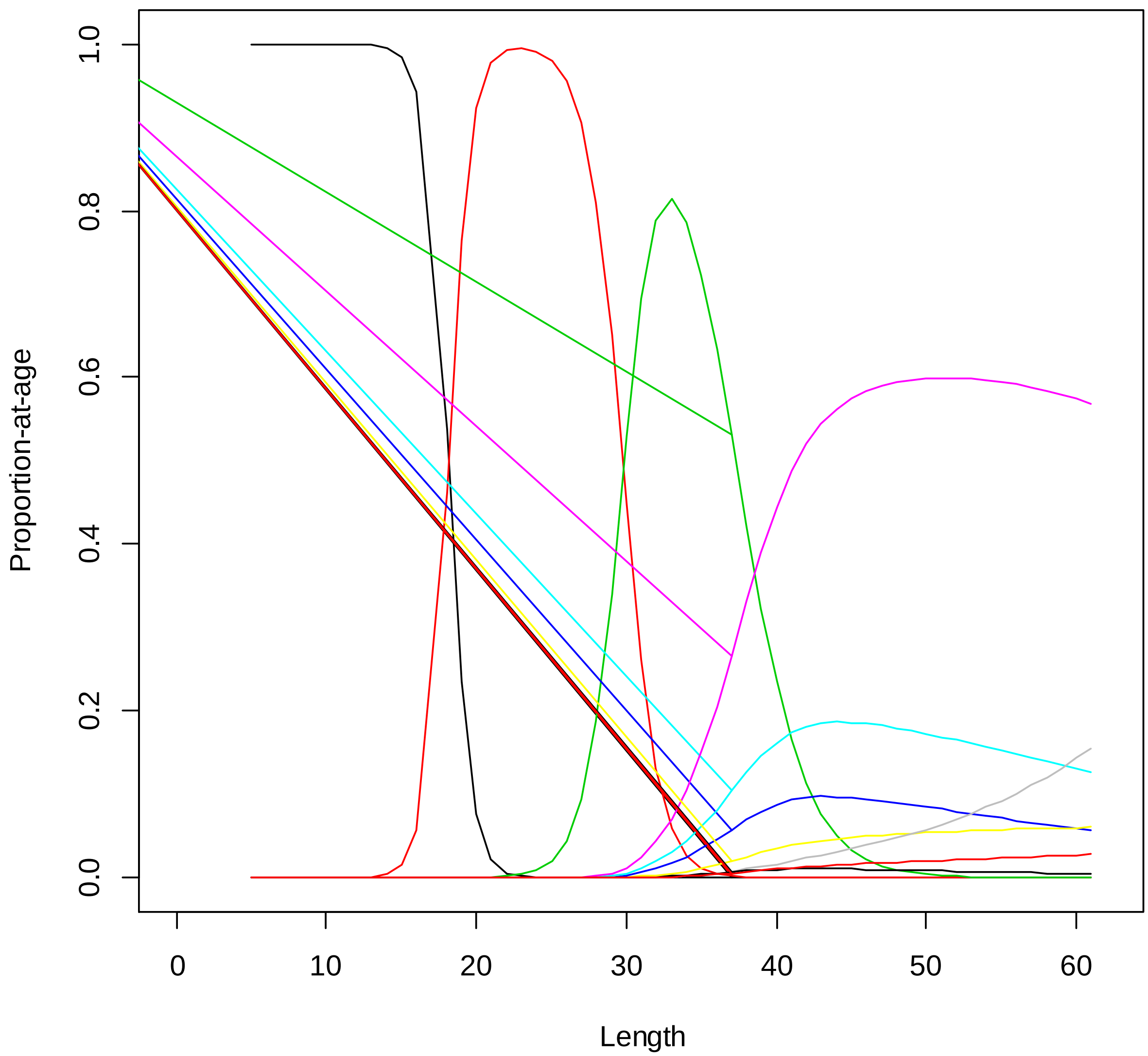


Figure 7: Multinomial fit of all the whiting otoliths in 2014 Q3 in roundfish area 1. Black(left side) = age-0, red = age-1, green=age-3, etc.

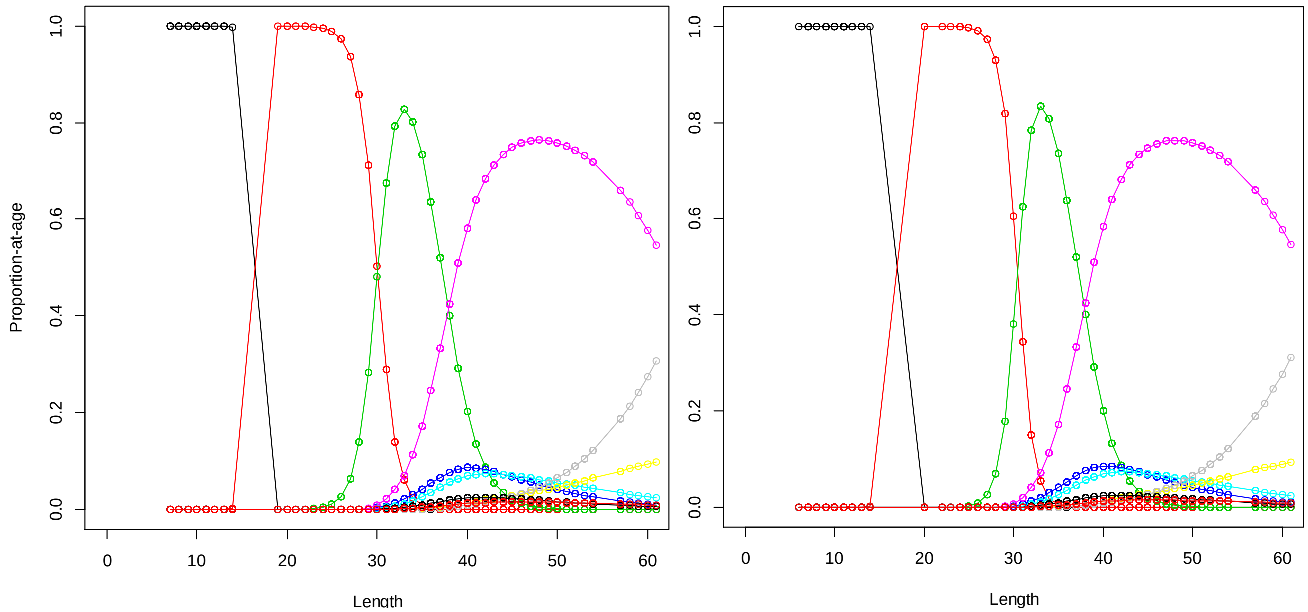


Figure 8: Two multinomial fits of the Scottish haddock otoliths in 2014 Q3 in roundfish area 1, selecting no otoliths of 5cm or smaller, 1 otolith per 5cm till 30cm and 1 otolith per 1cm above 30cm. Overlapping both figures would, while difficult to see, actually show that there is a small difference.

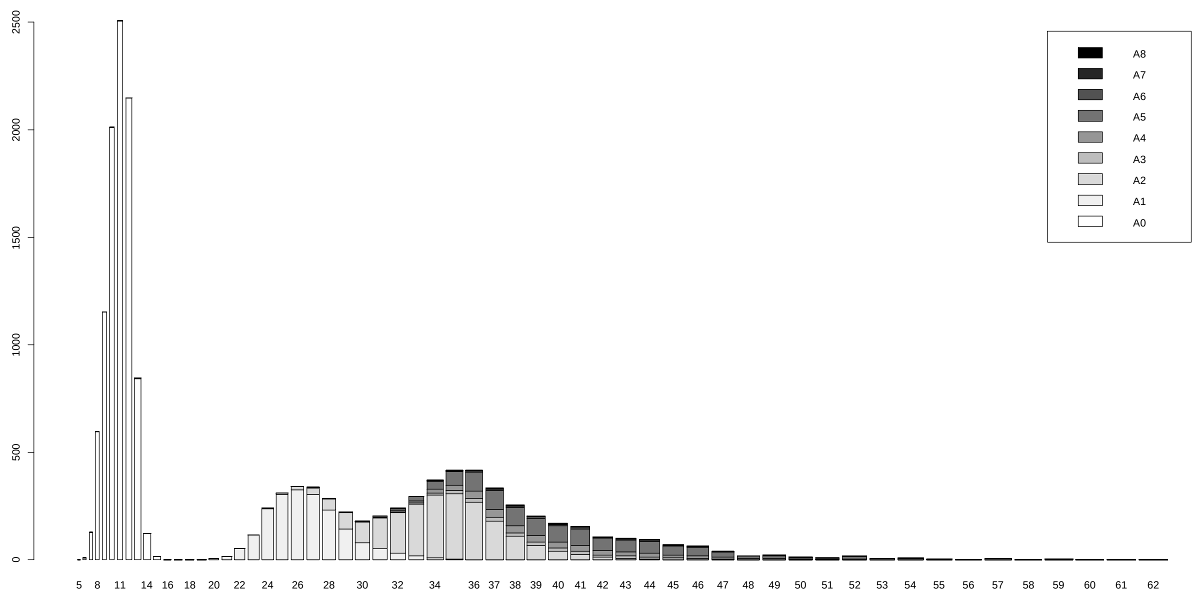


Figure 9: Total number of haddock caught in 2014 Q3 in RF1 by all countries, by age based on the complete ALK (1615 otoliths).

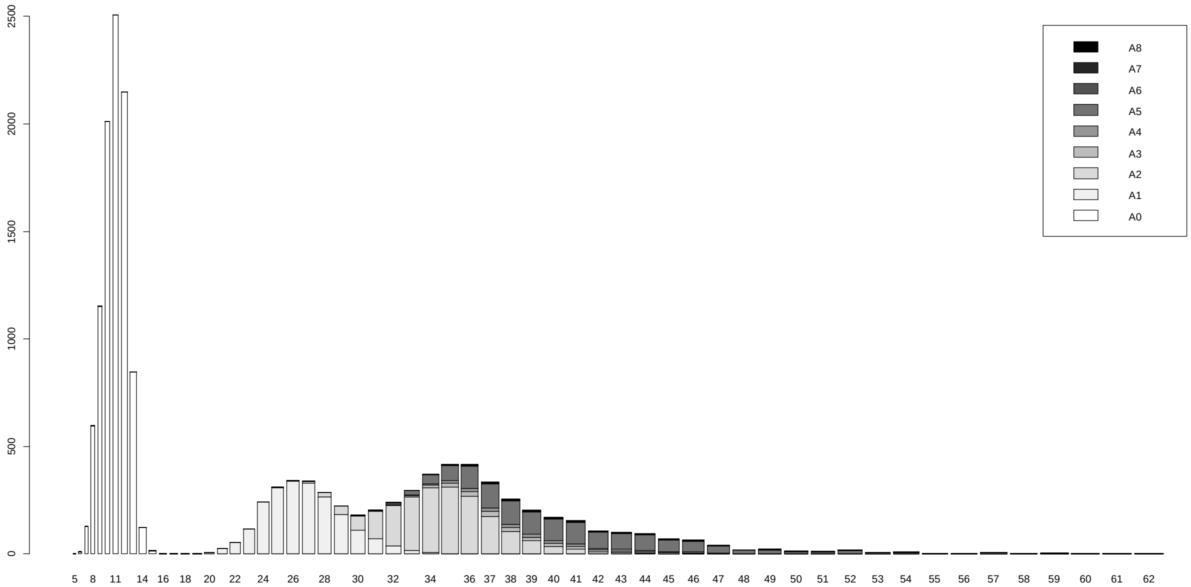


Figure 10: Total number of haddock caught in 2014 Q3 in RF1 by all countries, by age based on two random sets of the smallest number of Scottish Otoliths (406).

Norway Pout

Norway pout is different from whiting and haddock due to its smaller length range. The maximal length for which otoliths were collected in 2014 Q3 RF1 is 23 cm. This results in a modelled ALK as shown in figure 11. It shows only 6 ages. The majority of Norway pout caught is below <10 cm, which are all age-0 (fig 14).

Fitting the ALK based on all the Scottish otoliths from RF1 shows only 4 ages. (Fig 12) The ALK for ages-0, 1 and 2 is more or less the same as based on all the otoliths for RF1. However this figure indicates that above 15 cm more otoliths are required than currently found in the Scottish data alone.

A subset of the Scottish data was created by selecting no otoliths < 5cm, 1 otolith from the length classes 5-10, 11-15 cm, and >15 1 otolith per cm. This resulted in a reduction from 262 to 130 otoliths. Resulting in nearly the same ALK (fig 13).

Using the complete ALK or the subset ALK has not an effect on the estimates of total numbers at age till a length of 15cm. Above that the difference is because of the lack of older Norway pout in the Scottish data, if at least some of age 4 and 5 would have been present in the Scottisch data. The difference would have been neglect able.

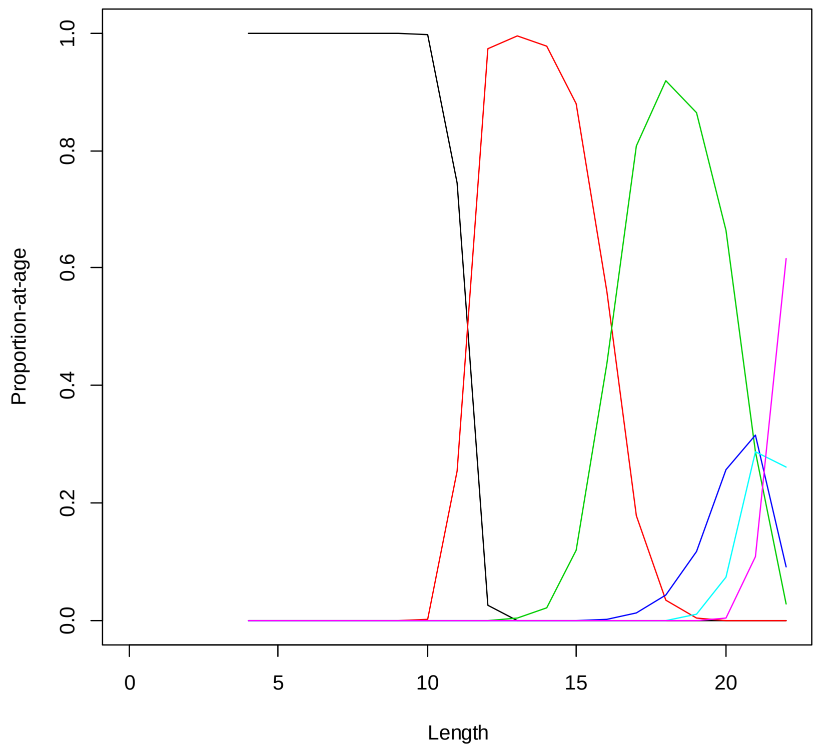


Figure 11: Multinomial fit of all the Norway pout otoliths in 2014 Q3 in roundfish area 1. Black(left side) = age-0, red = age-1, green=age-3, etc.

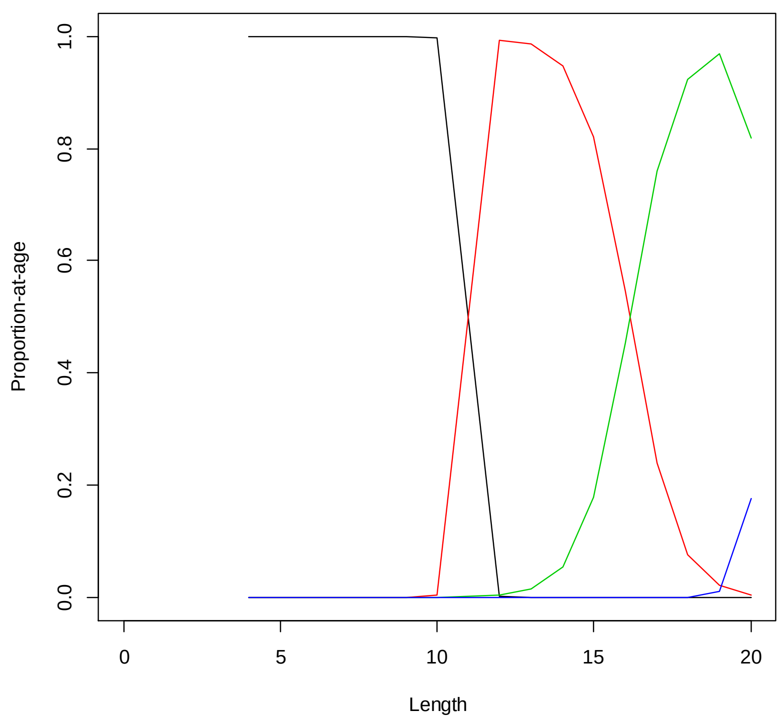


Figure 12: Multinomial fit of the Scottish Norway pout otoliths in 2014 Q3 in roundfish area 1. Black(left side) = age-0, red = age-1, green=age-3, etc.

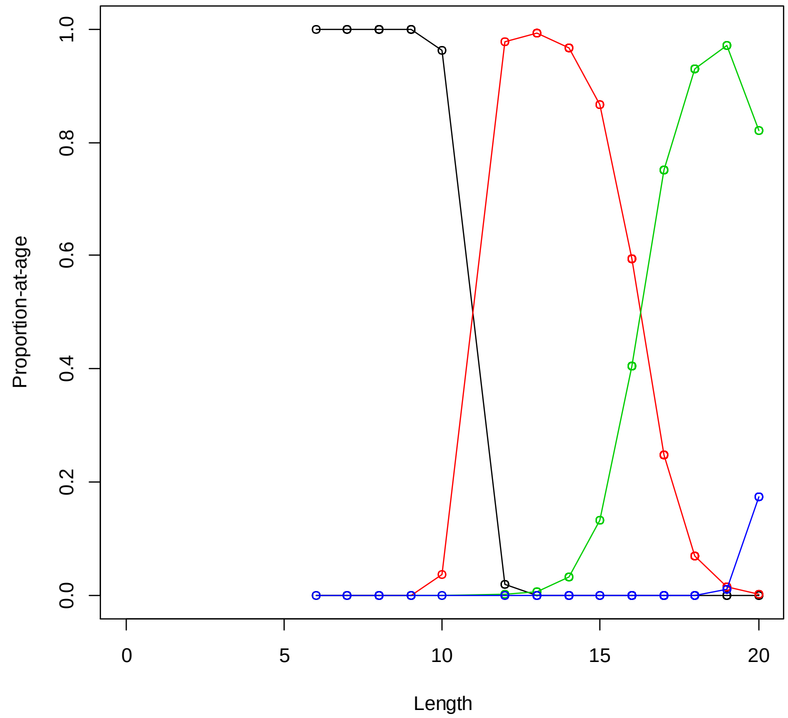


Figure 13: Multinomial fit of a subset of the Scottish Norway pout otoliths in 2014 Q3 in roundfish area 1. Black(left side) = age-0, red = age-1, green=age-3, etc. selecting no otoliths of 5cm or smaller, 1 otolith per 5cm till 15 cm and 1 otolith per 1cm above 15cm.

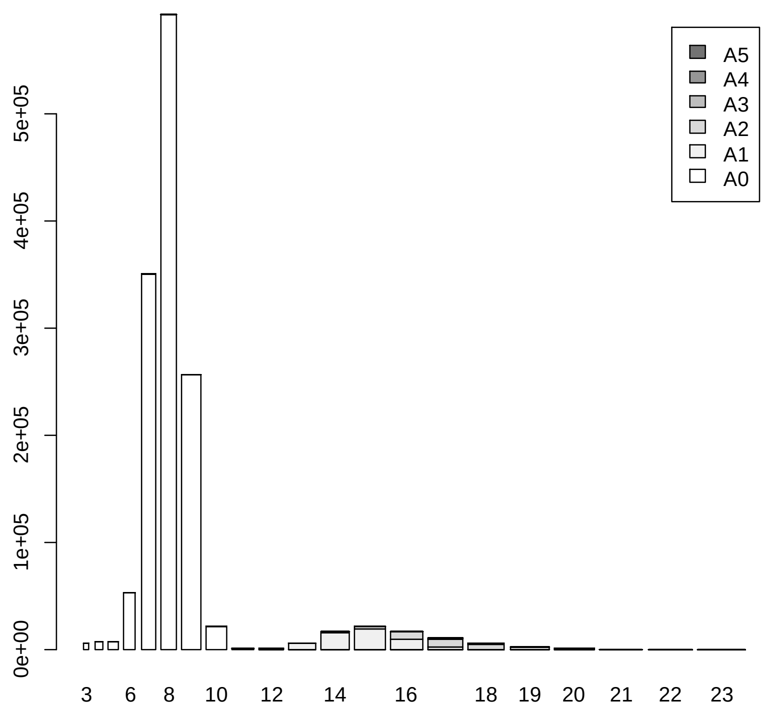


Figure 14: Total number of Norway pout caught in 2014 Q3 in RF1 by all countries, by age based on the complete ALK (911 otoliths).

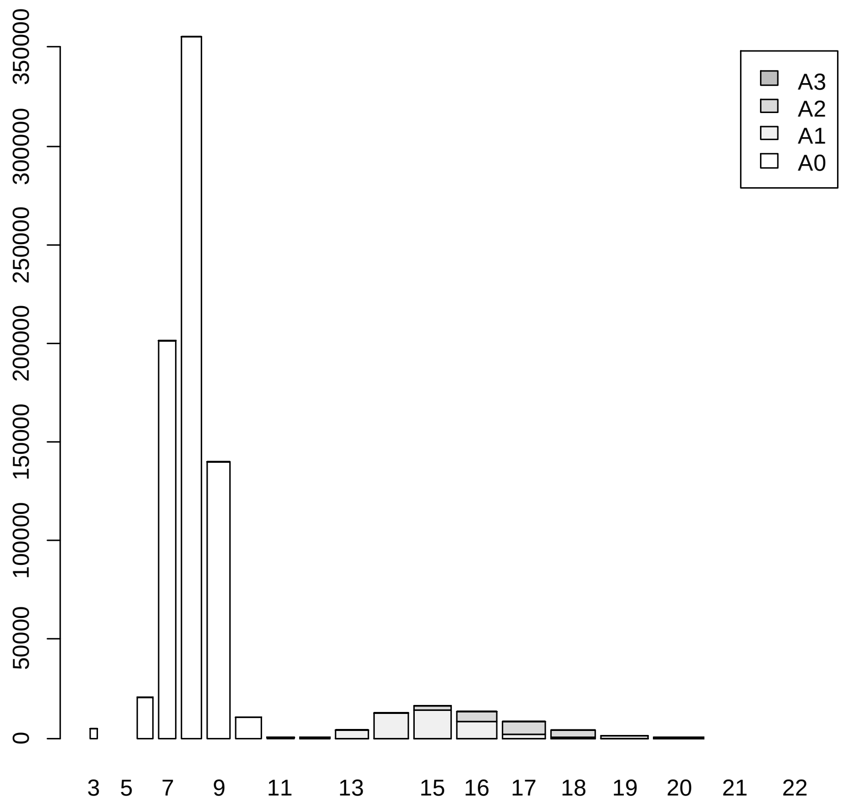


Figure 15: Total number of Norway pout caught in 2014 Q3 in RF1 by all countries by age based on two random sets of the smallest number of Scottish Otoliths (130).

5. Advice

The advice for whiting and haddock in Q3 would be:

1. Collect the otoliths by sampling station.
2. Below 10 cm no otoliths need to be collected
3. For the length classes 11-15, 16-20, 21-25, 26-30 cm: 1 otolith per 5 cm per sampling station
4. Above >30 cm collect 1 otolith per cm.

However, as these are very quick and dirty analysis, the current advice actually is to collect 2 otoliths per 5 cm class. And if capacity allows it feel free to collect additional otoliths.

The advice for Norway pout in Q3 would be:

1. Collect the otoliths by sampling station.
2. Below 5 cm no otoliths need to be collected
3. For the length classes 5-10,11-15, cm: 1 otolith per 5 cm per sampling station
4. Above >15 cm collect 2 otolith per cm (as only a very small number of these is caught).

However, as these are very quick and dirty analysis, the current advice actually is to collect 2 otoliths per 5 cm class and collect a higher number of otoliths above 15cm. And if capacity allows it feel free to collect additional otoliths.

Analysis of Evhoe and IGFS survey data in the Celtic Sea for optimising the sampling design

Verena Trenkel, Ifremer Nantes, France

Summary

The objectives of this study were

1. Compare abundance indices derived from Evhoe and IGFS data from 2003 onwards to determine whether joint abundance indices could be calculated, at least for a certain number of species.

2. Compare the precision of abundance estimates using different stratification schemes; similarly for the aptitude to track cohorts of cod and whiting.

3. Evaluate the potential change in precision of abundance estimates and the capacity to track cohorts for the case where the Evhoe survey only sampled south of 51°N.

The results indicated that survey indices derived from Evhoe and IGFS surveys were well correlated for most species, which indicates that that the data from the two surveys can be used together for deriving abundance indices.

The results showed that for certain species a decrease in CV can be obtained by using the new stratification scheme or by using all IGFS and only Evhoe hauls south of 51°. For 16 out of 37 species using the new stratification with all IGFS and Evhoe hauls or only those south of 51°N would lead to increased precision in abundance estimates. For six species a smaller CV was obtained for the Evhoe stratification scheme and combining IGFS data with Evhoe hauls south of 51°. For the remaining species the increase in CV was generally less than 5% on average using the best combination of stratification scheme and data set. For some species relatively large interannual variations in CVs were observed.

Five commercially important species were investigated in more details. For cod, whiting and angles highest CVs were obtained using the Evhoe stratification. Using a small grid (0.5° x 0.5°) in the overlap area between IGFS and Evhoe lead to the smallest CVs for cod. However, this might be an artefact as only one haul was available for a certain number of cells which means that the variance was artificially zero for those cells. For cod the percentage of the abundance found in those grid cells with only one haul was around 50% in several years. Thus, using the small grid as strata for deriving abundance indices for cod might not be appropriate for the historic data series. Finally, time trends in abundance estimates were robust to the choice of stratification scheme or sampling plan.

Result for cohort tracking...

In conclusion limiting the Evhoe sampling plan to the area south of 51°N would have saved 14 hauls on average (range 8 to 21) without much influencing the precision of abundance estimates or their time trends. More importantly, different post-stratification schemes for different species might be a way forward to increase the precision and robustness of survey abundance indices.

1. Introduction

The French Evhoe groundfish survey has been carried out annually since 1997 in the Celtic Sea on R/V Thalassa using a fixed sampling stratification scheme by depth and latitude. Evhoe covers the area from 48°N to 52°N. An Irish Groundfish Survey on R/V Celtic Voyager and two commercial vessels existed during the early time period. Since 2003 the R/V Celtic Explorer covers the whole area to the North of 50.5° N in the Celtic Sea and around the west of Ireland. This survey series is known as the Irish Groundfish Survey (IGFS). The sampling scheme is area stratified and differs from that used by Evhoe. Both surveys use a GOV trawl with some slight differences.

Several studies comparing Evhoe and Irish data have been performed using data collected before and after 2003. An intercalibration study carried out in 1999 and 2000 within the EU funded IPROSTS project found that there was no statistical evidence to support the hypothesis that the catches of Thalassa and Celtic Voyager were different, despite the fact that the smaller Celtic Voyager used a smaller trawl (Mahé et al. 2001). The same study found a linear positive effect of depth on wing spread and door spread for both surveys (only down to 120 m for Evhoe as a gear change occurs beyond this depth).

More recently, data collected since 2003 were compared for cod and whiting in view of creating for each species a single survey index for stock assessment purposes. For cod, Stokes (2012) found that cohort tracking using estimated survey numbers-at-age seemed to be clearest if Evhoe and IGFS data were combined using a grid spanning the area between 50.5° and 52° North and from 11° to 5° East. The size of the grid cells was 0.5° x 0.5°. Numbers-at-age were first averaged within each grid cell and then summed to obtain the survey index for cod. Note that this method does not cover the whole stock area of cod in the Celtic Sea but only the core area. For developing a survey index for haddock, Gerritsen (2012) first compared the catches at close-by stations. The study found that Evhoe and IGFS catches were similar both in abundance and length-frequency distribution. For creating a single abundance index for haddock Gerritsen proposed that the catches of each survey should first be raised separately using the stratification scheme of each survey and then combined by weighing each index with the total survey area.

In conclusion, a general comparison between Evhoe and the Irish groundfish survey data has only been made for the period before 2003 after which the Irish survey had several modifications. Only for cod and haddock was the question considered how to create single survey indices for the current period. In the case of cod this involved using a grid as stratification for abundance estimation instead of the stratification schemes used for defining survey hauls.

In view of optimising the stratification scheme and the number of hauls carried out in the Celtic Sea the objectives of this study are

4. Compare abundance indices derived from Evhoe and IGFS data from 2003 onwards to determine whether joint abundance indices could be calculated, at least for a certain number of species.

5. Compare the precision of abundance estimates using different stratification schemes; similarly for the aptitude to track cohorts of cod and whiting.

6. Evaluate the potential change in precision of abundance estimates for the case where the Evhoe survey only sampled south of 51° North.

2. Comparison between Evhoe and IGFS survey indices

For comparing stratified abundance and men length estimates derived from Evhoe and IGFS data, only hauls from the overlap area were used for the period 2005 – 2012 (except 2010). The Evhoe strata were used for both data sets (in colour in Figure 1).

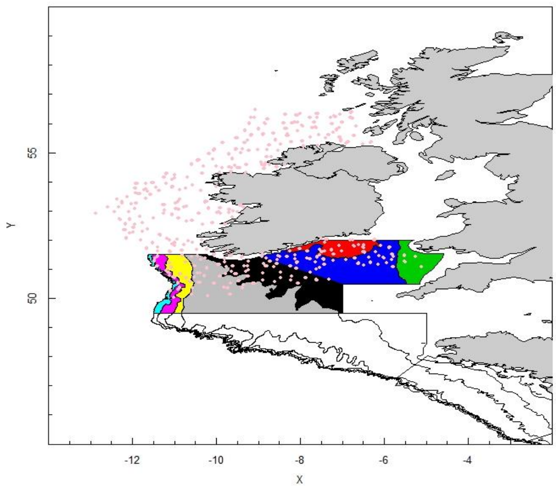


Figure 1. Evhoe strata in colour for overlap area between IGFS and Evhoe surveys in Celtic Sea. Only hauls from this overlap area were used in the comparison in this section.

Time series of abundance and biomass indices by species were compared using principal component analysis. Rare species were excluded from this analysis. The results showed strong overlap between IGFS and EVHOE survey data with respect to abundance and biomass time series trends by species (Figure 2). The good agreement between the two surveys is confirmed for most species as the two abundance time series are positively correlated (Figure 3). The results for biomass are similar (not shown).

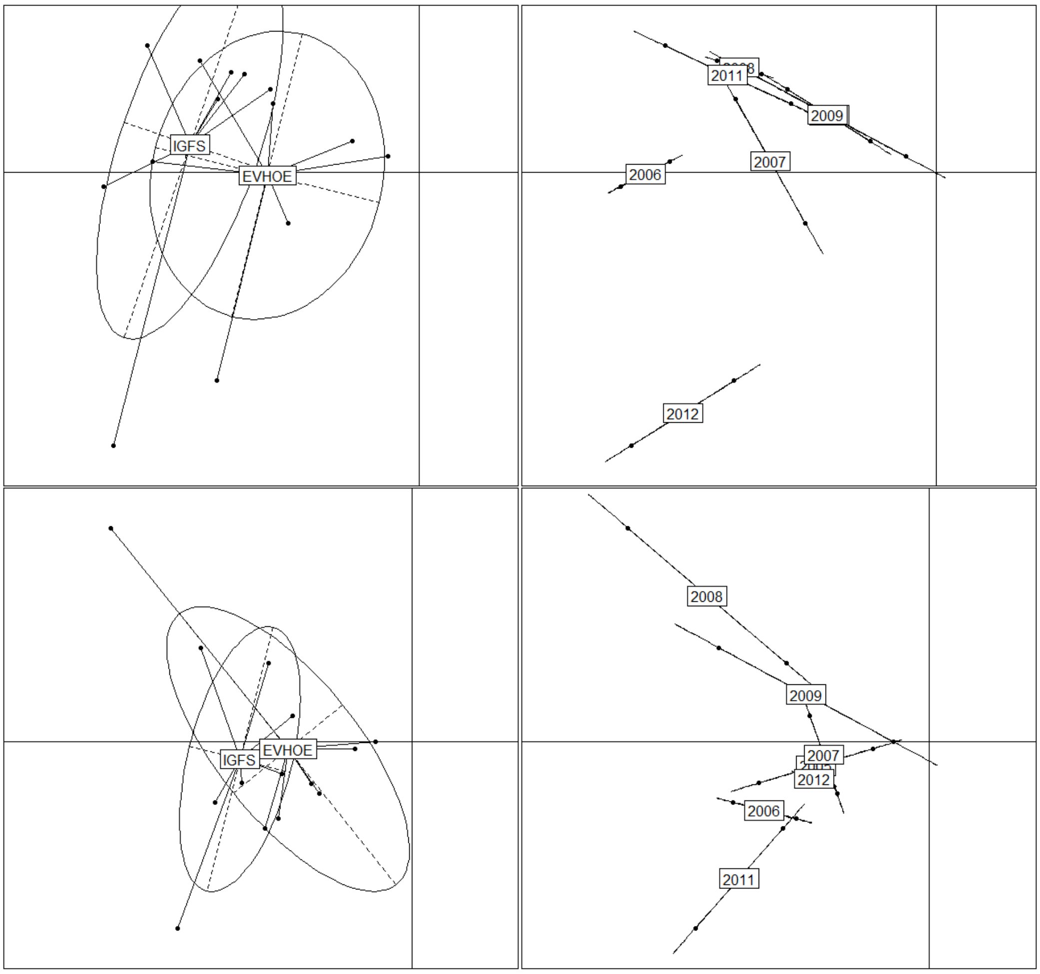
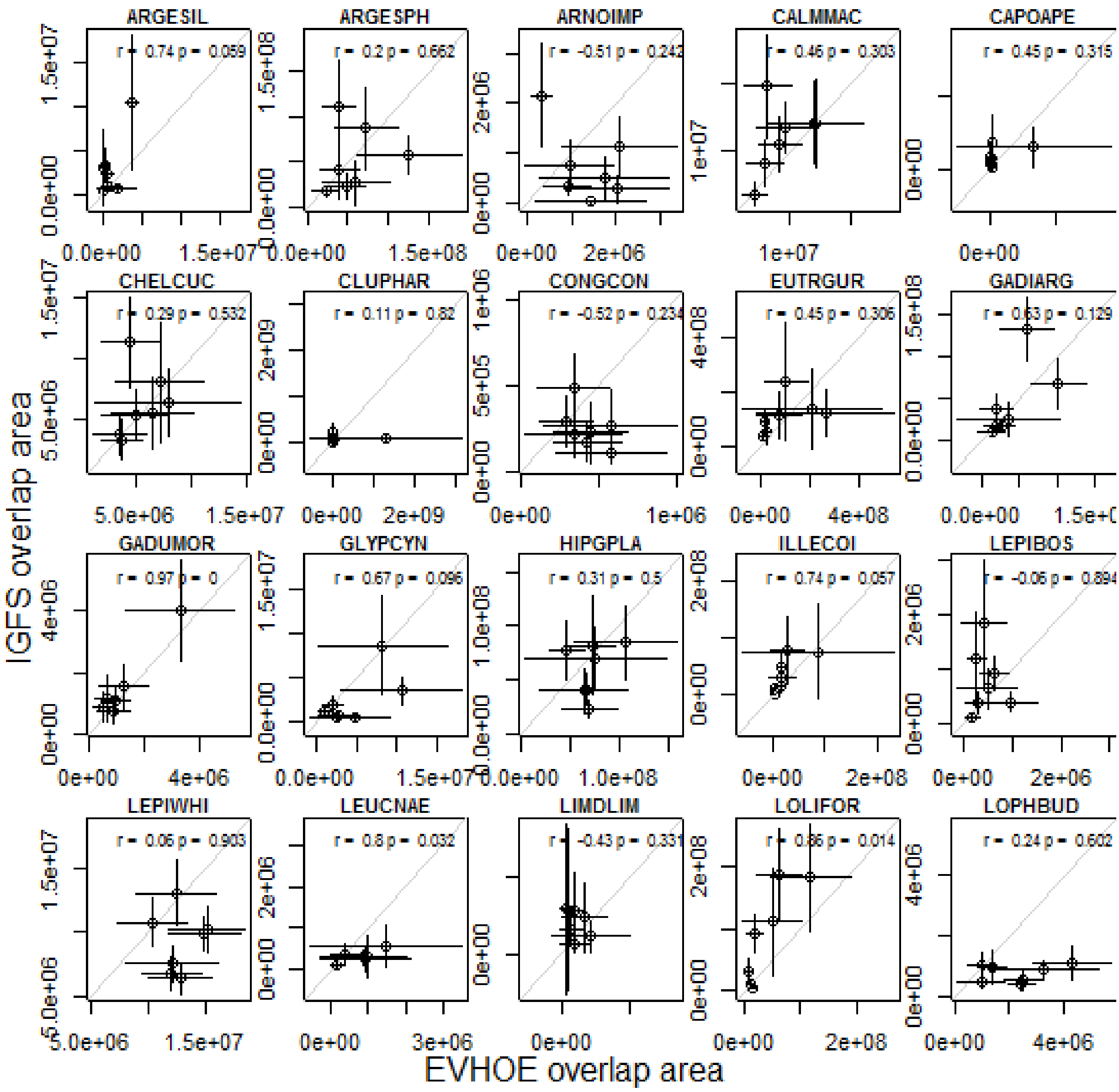


Figure 2. PCA results of abundance (top) and biomass (bottom) index time series derived from IGFS and Evhoe data in the overlap area depicted in figure 1.


ARGESIL
r = 0.74 p = 0.059
ARGESPH
r = 0.2 p = 0.662
ARNOIMP
r = -0.51 p = 0.242
CALMMAC
r = 0.46 p = 0.303
CAPOAPE
r = 0.45 p = 0.315
CHELCUC
r = 0.29 p = 0.532
CLUPHAR
r = 0.11 p = 0.82
CONGCON
r = -0.52 p = 0.234
EUTRGUR
r = 0.45 p = 0.306
GADIARG
r = 0.63 p = 0.129
GADUMOR
r = 0.97 p = 0
GLYPCYN
r = 0.67 p = 0.096
HIPGPLA
r = 0.31 p = 0.5
ILLECOI
r = 0.74 p = 0.057
LEPIBOS
r = -0.06 p = 0.894
LEPIWHI
r = 0.06 p = 0.903
LEUCNAE
r = 0.8 p = 0.032
LIMDLIM
r = -0.43 p = 0.331
LOLIFOR
r = 0.86 p = 0.014
LOPHBUD
r = 0.24 p = 0.602
IGFS overlap area
EVHOE overlap area

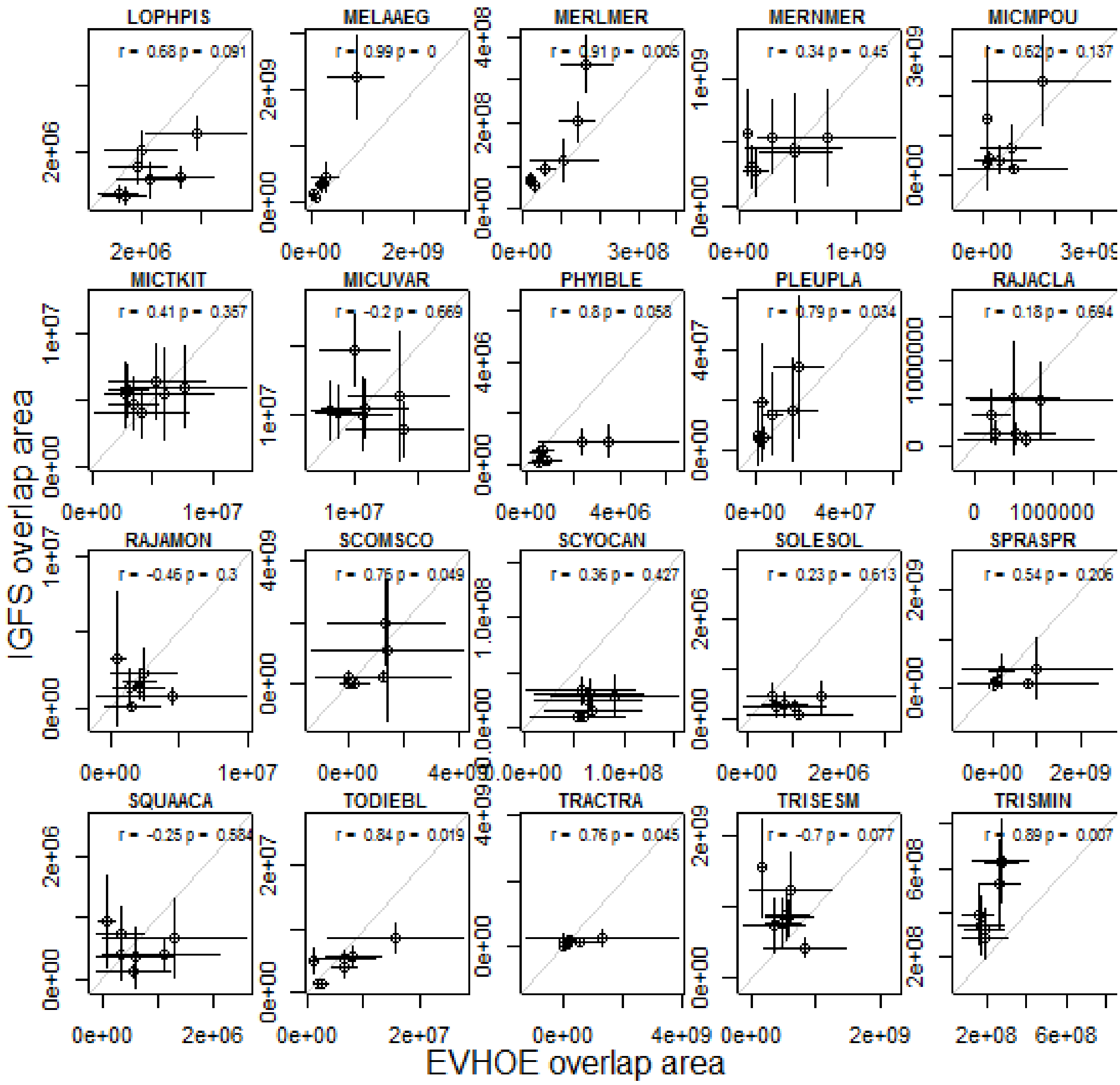

LOPHPIS
r = 0.68 p = 0.091
MELAAEG
r = 0.99 p = 0
MERLMER
r = 0.91 p = 0.005
MERNMER
r = 0.34 p = 0.45
MICMPOU
r = 0.62 p = 0.137
MICTKIT
r = 0.41 p = 0.357
MICUVAR
r = -0.2 p = 0.669
PHYIBLE
r = 0.8 p = 0.058
PLEUPLA
r = 0.79 p = 0.034
RAJACLA
r = 0.18 p = 0.694
RAJAMON
r = -0.46 p = 0.3
SCOMSCO
r = 0.75 p = 0.049
SCYOCAN
r = 0.36 p = 0.427
SOLESOL
r = 0.23 p = 0.613
SPRASPR
r = 0.54 p = 0.206
SQUAACA
r = -0.25 p = 0.584
TODIEBL
r = 0.84 p = 0.019
TRACTRA
r = 0.76 p = 0.045
TRISESM
r = -0.7 p = 0.077
TRISMIN
r = 0.89 p = 0.007
IGFS overlap area
EVHOE overlap area

Figure 3. Annual abundance indices estimated in overlap area (see figure 1) using IGFS survey data plotted against those derived from Evhoe survey data; in both cases the Evhoe stratification scheme was used. Evaluation of the precision of joint Evhoe and IGFS abundance estimates

Methods

The previous section showed that survey indices derived from either IGFS or Evhoe were positively correlated for many species, in this section the precision of abundance indices derived from the joint data set covering the period 2005 to 2012 (except 2010) was studied. For this four stratification schemes were compared (Figure 4)

a) **Evhoe** stratification (blue lines in fig. 4a)

b) **New** stratification (red lines in fig. 4a)

c) Small grid (**Sgrid**) stratification (0.5° x 0.5°; fig. 4b)

d) Large grid (**Lgrid**) stratification (1° x 0.5°; fig. 4c)

The so called New stratification scheme was developed by Kupschus et al. in the UK funded TIME project based on analysing spatial patterns in onboard fishing vessel observations, survey data, environmental data, VMS data etc. This new stratification scheme does not cover the deepest Evhoe strata (<400m): all of Cc7, some of Cs7, Cc6 and Cs6) and the area South of 48°N. Both the small and the large grid only cover a small part of the northern Celtic Sea next to Ireland. They were used for a list of selected species only.

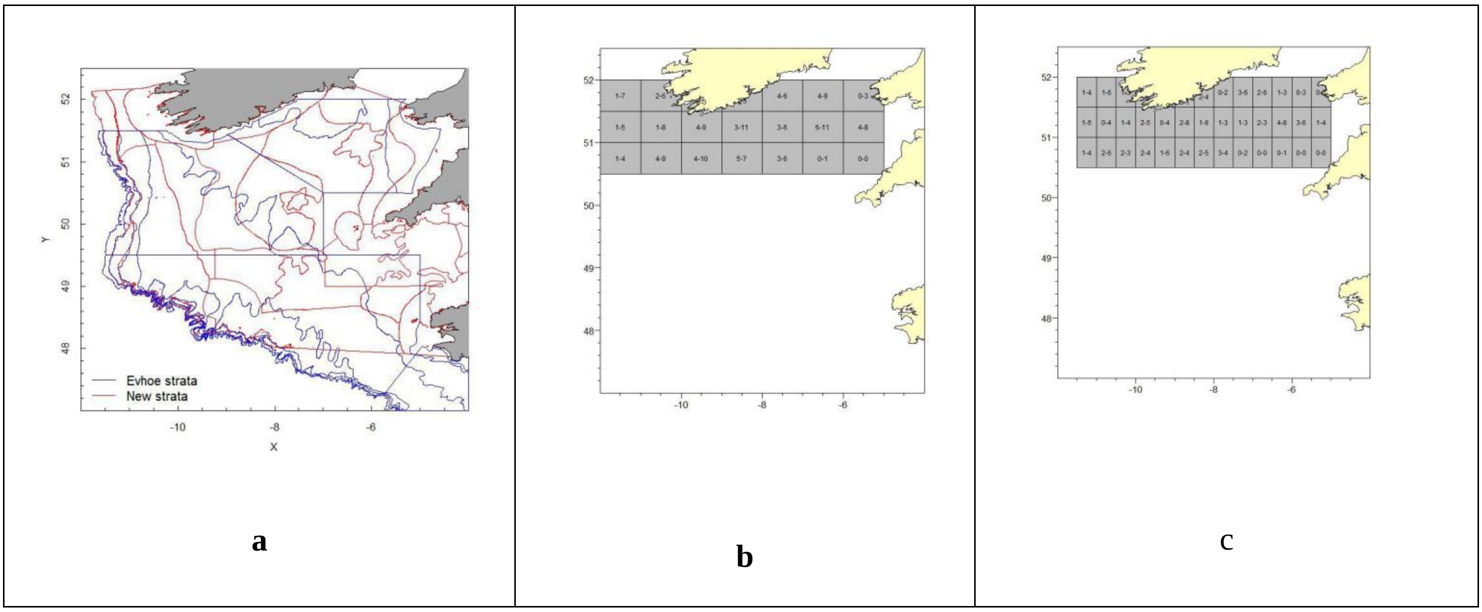


Figure 4. a) Evhoe strata and new stratification scheme based on aalysis of species assemblages in onboard observations from Ireland, France and UK. Stratification using regular grid in overlap area with b) small grid cells (0.5° x 0.5°) and c) large grid cells (1° latitude by 0.5° longitude); numbers indicate the range of number of hauls for the joint EVHOE and IGFS data set for the years 2005-2012 (2010 missing). The smaller grid is currently used for calculating a joint survey index for the cod stock in the Celtic Sea (VIIe-k) (Stokes 2012).

To explore the effects of harmonising the joint survey coverage between Evhoe and IGFS, each of the four stratification schemes was also applied to a data set with a reduced number of hauls. For this harmonised sampling design only hauls carried out by Evhoe south of 51° North were retained. Both surveys still overlap in the area between 50.5°N and 51°N (see maps in Annexe 1). Maintaining this overlap will allow for studying vessel effects.

For each survey time series, Evhoe and IGFS, the number of hauls considered in each of the four stratification schemes are summarised in table 1. Removing all hauls North of 51° from the Evhoe sampling program saves 14 hauls on average, with a minimum of 8 in 2013 and 1997 and a maximum of 21 in 2011. A similar number hauls are saved for Evhoe if the new stratification scheme is used as for this the depth limit is 400m. For IGFS an opposite effect occurs as the new stratification scheme has a slightly larger northwards extension compared to the Evhoe stratification scheme (see Fig 1a). If one of the grids is used as stratification scheme for abundance estimation, only ¼ to 1/3 of the Evhoe hauls are used, but most IGFS hauls in the Celtic Sea. Details on the number of hauls not considered are given in annexe 2.

Table 1. Number of hauls in Celtic Sea for current Evhoe (IGFS) stratification scheme considering the current spatial coverage (Evhoe all; IGFS all), the same stratification but no hauls North of 51° (Evhoe South 51°N), a New stratification scheme and two grids covering the overlap area between the two surveys. See figure 1 spatial definition of stratification schemes.

	EVHOE time series				**IGFS time series**	
Year	**Evhoe all**	**Evhoe South 51°N**	**New stratification**	**Grids**	**Evhoe all**	**New Stratification**
1997	52	44	45	14		
1998	60	48	54	20		
1999	63	48	52	22		
2000	53	42	45	16		
2001	82	66	72	25		
2002	82	67	70	26		
2003	83	68	69	25		
2004	69	57	59	20		
2005	76	62	65	24	47	61
2006	65	53	57	21	55	72
2007	77	63	66	22	67	74
2008	78	63	61	22	63	73
2009	68	56	57	17	55	64
2010	71	54	55	23		
2011	81	60	64	27	75	85
2012	65	47	51	21	76	86
2013	71	63	56	18		

For each stratification scheme and both the full and reduced data sets, abundance indices for 37 species were then estimated using a design based stratified estimator. Hauls were standardised by their swept area and raised to the total stratum using the stratum surface. The precision of abundance estimates was determined using the coefficient of variation, standard deviation divided by the mean estimate. Finally, for cod and whiting the capacity to track cohorts was compared between the different stratification and sampling schemes.

Results

The average CV of annual abundance estimates by species differed little between stratification schemes (Figure 5). This can be seen more clearly when considering the average relative change in CV compared to the CV obtained with the Evhoe stratification scheme and all hauls (Figure 6). For certain species a decrease in CV can be obtained by using the new stratification scheme or by using all IGFS and only Evhoe hauls south of 51°. For 16 out of 37 species using the new stratification with all IGFS and Evhoe hauls or only those south of 51° would lead to increased precision in abundance estimates. For six species a smaller CV is obtained for the Evhoe stratification scheme and combining IGFS data with Evhoe hauls south of 51°. For the remaining species the increase in CV is generally less than 5% on average using the best combination of stratification scheme and data set. Boxplots of relative changes by year confirm the results based on average values, but also indicate that there are differences between years (Figure 7). These year effects might be due to the varying number of hauls that were carried out in each year (table 1).

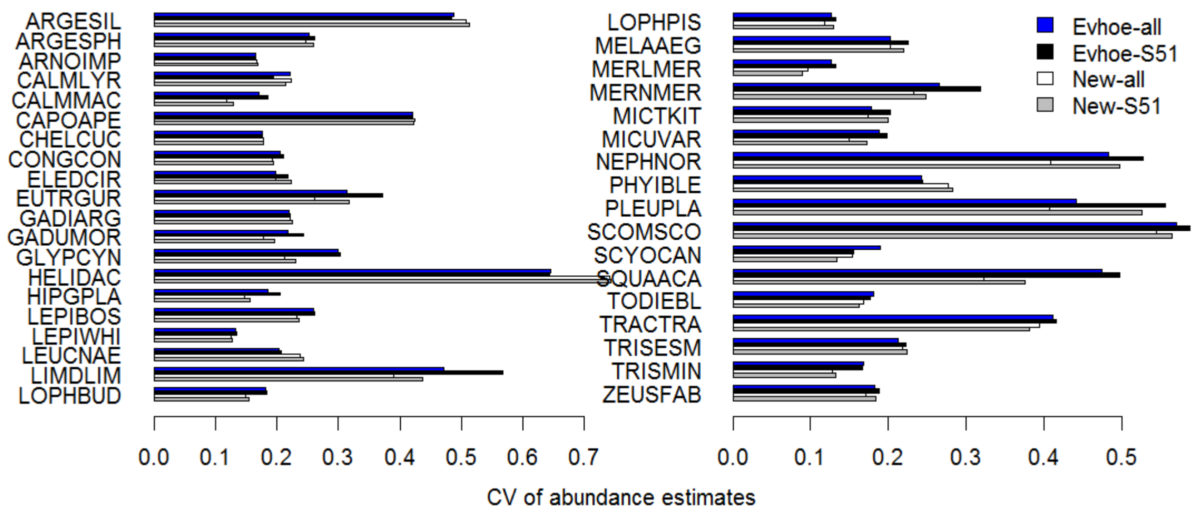


Figure 5. Average CV of annual abundance estimates by species for different stratification schemes (Evhoe or New) and data sets (all hauls or IGFS & Evhoe hauls south of 51°).

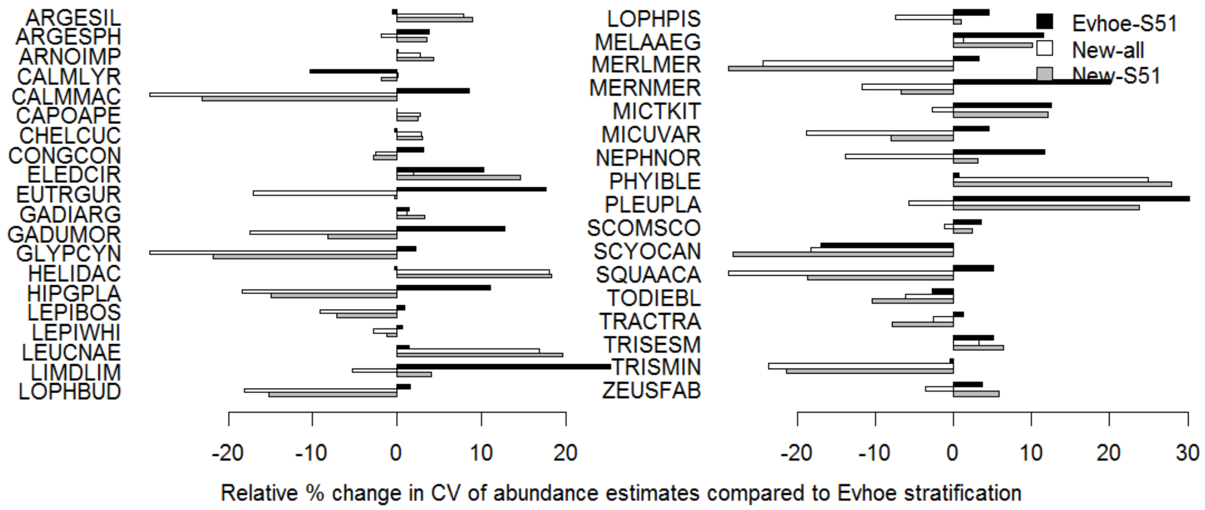


Figure 6. Relative % change in the CV for abundance estimates averaged over the period 2005 to 2012 for different stratification schemes (Evhoe or New) and data sets (all hauls, IGFS & Evhoe south of 51°). The baseline is the Evhoe stratification using all hauls (blue in figure 5).

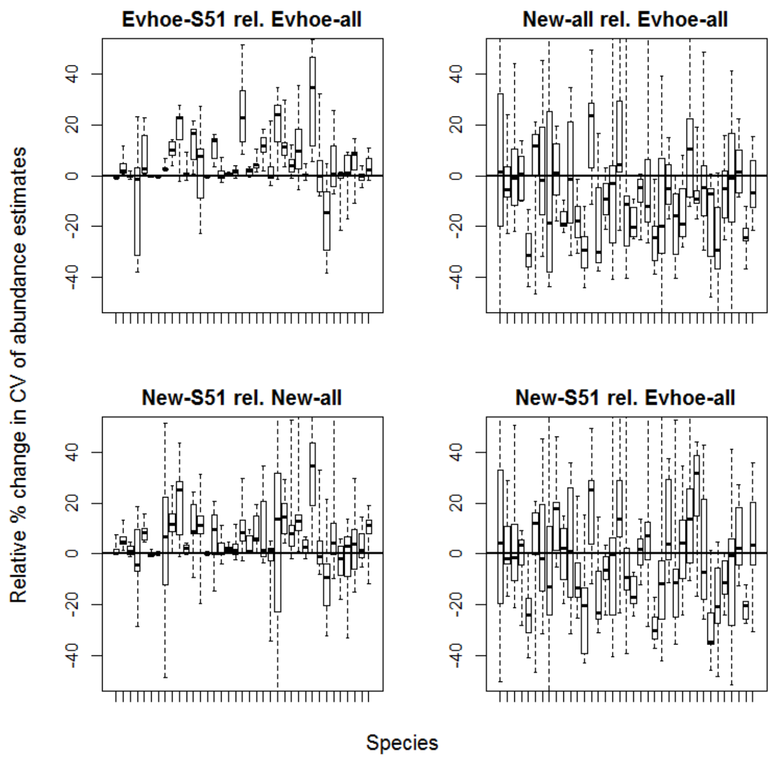


Figure 7. Boxplots of relative % change in annual CVs for abundance estimates for 2005 to 2012 for different stratification schemes (Evhoe or New) and data sets (all hauls, IGFS & Evhoe south of 51°). The baseline is the Evhoe stratification using all hauls (blue in figure 5).

For five commercially important species the results were analysed in more details. Maps with average spatial distributions of these species can be found in appendix 3. In addition to the two stratification schemes analysed above, the small and the large grid were also used. For most species using different stratification schemes changed the CV of abundance estimates more than only using Evhoe hauls south of 51° (Figure 8). For cod, whiting and angles higher CVs were obtained when the Evhoe stratification. The small grid lead to smaller CVs compared to the large grid for all species and years. However, this might be an artefact as only one haul was available for a certain number of cells of the small grid which means that the variance was zero for those cells. For cod the percentage of the abundance found in those grid cells with only one haul was around 50% in several years (Figure 9). Thus, using the small grid as strata for deriving abundance indices for cod is not appropriate for the historic data series.

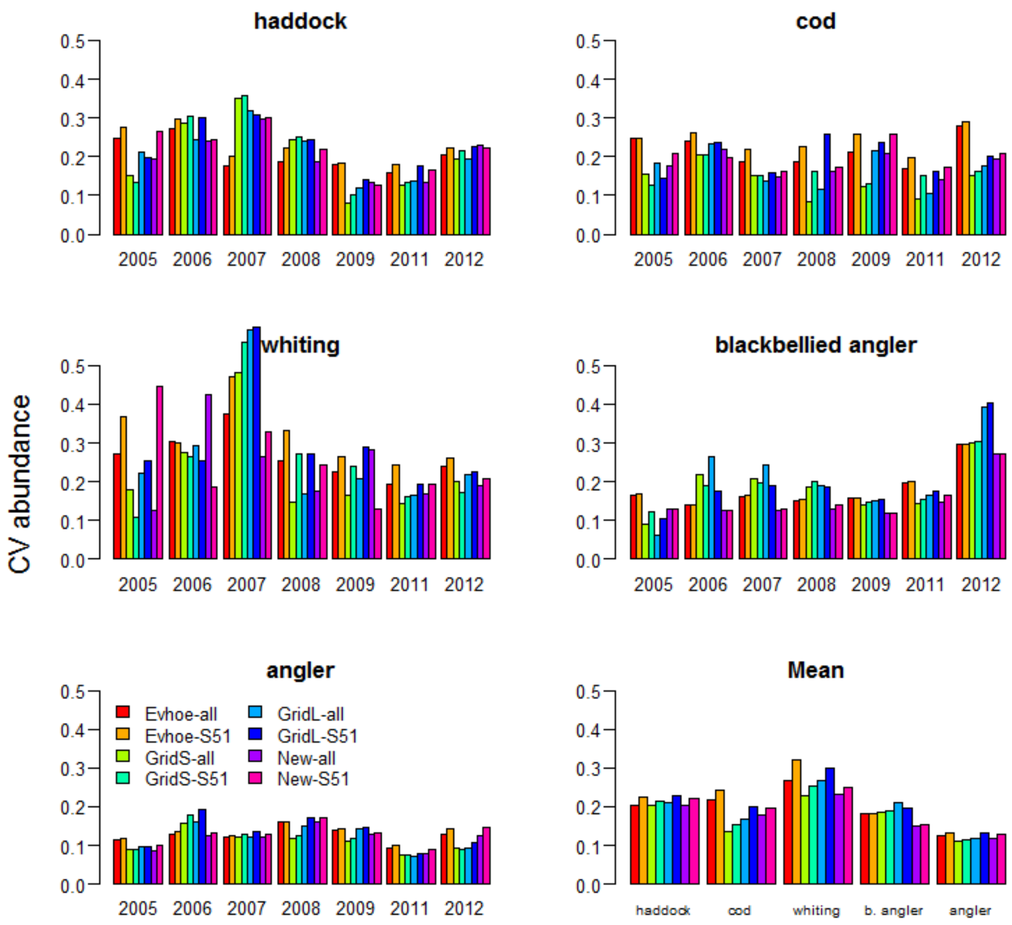


Figure 8. Annual CVs of abundance estimates for commercially important species using different stratification schemes (Evhoe, New, GridS small grid, GridL large grid) and data sets (all hauls or S51 which corresponds to all IGFS & Evhoe hauls south of 51°).

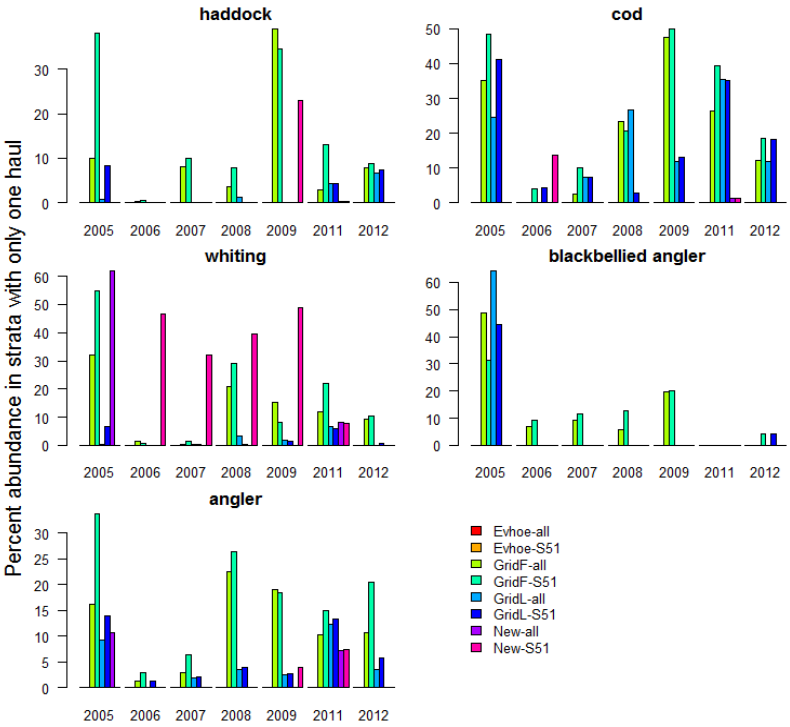


Figure 9. Percentage of abundance corresponding to CV estimates in figure 8 found in strata with only one haul.

Time trends in abundance estimates differed in magnitude between stratification schemes and the number of hauls used (Figure 10left). However, normalised time trends were comparable for four species except blackbellied angler (Figure 10right). Thus time trends in abundance estimates are robust to the choice of stratification scheme or sampling plan.

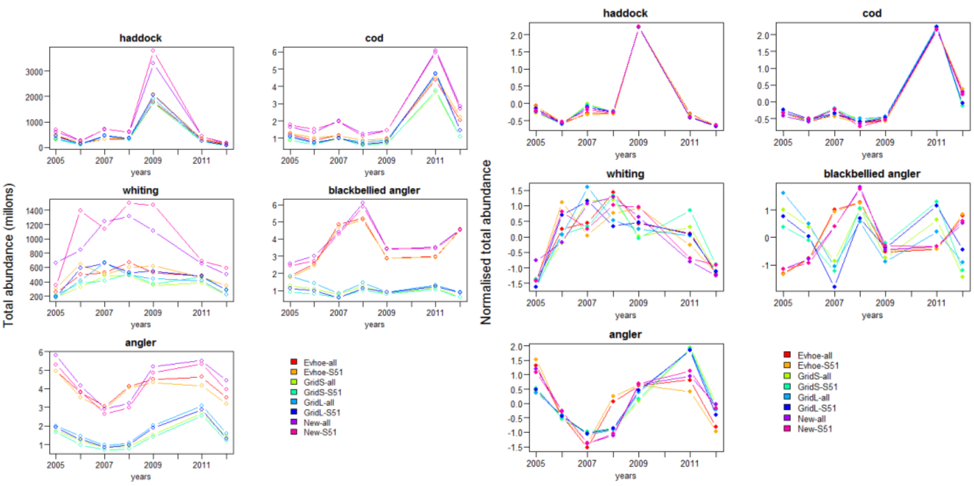


Figure 10. Time series of abundance estimates using different stratification schemes (Evhoe, New, GridS small grid, GridL large grid) and data sets (all hauls or S51 which corresponds to all IGFS & Evhoe hauls south of 51°). Left: absolute values assuming catchabilities equal to one. Right: normalised time series.

Next, for cod and whiting the capacity to track cohorts was compared between the different stratification and sampling schemes.

References

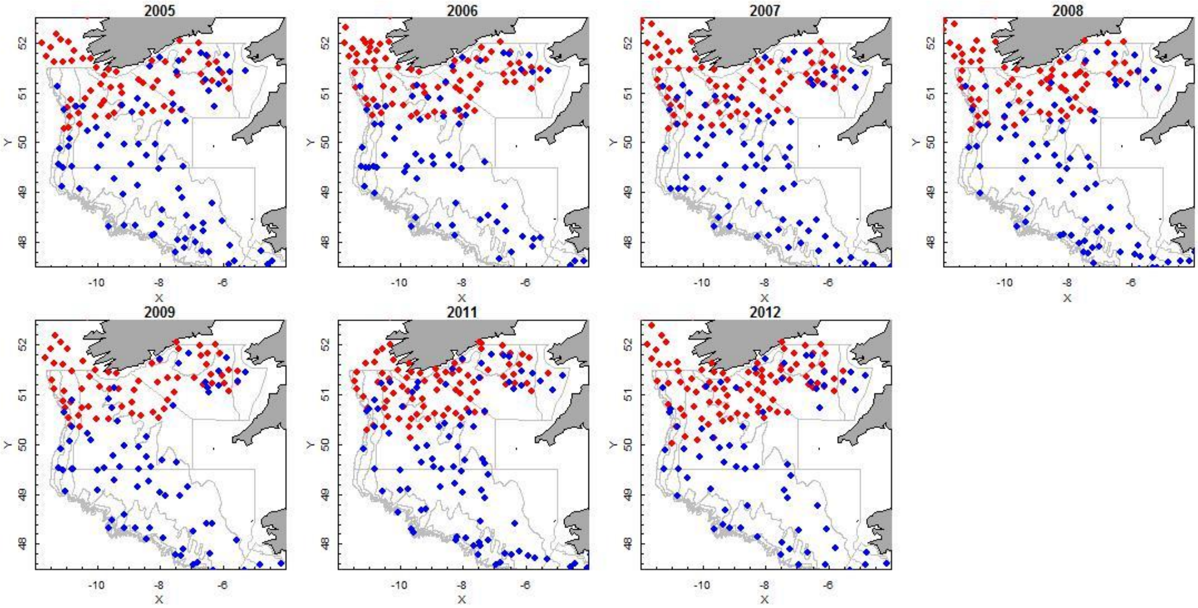
Gerritsen H.D., 2012, Haddock 7b-k combined IGFS-WIBTS-Q4 and EVHOE-WIBTS-Q4 surveys. Working document to ICES benchmark workshop on roundfish (WKROUND 2012), pp. 5.

Mahé J.-C., Bellail R., Newton A., Officer R., Reid D., Stokes D., Zuur A., 2001, International program of standardised trawl surveys. Lorient, Ifremer, pp. 155.

Stokes D., 2012, A proposed combined groundfish survey index for cod (*Gadus morhua*) in the Celtic Sea ICES Area VIIe-k. Working document 10 to ICES benchmark workshop on roundfish (WKROUND 2012), pp. 12.

Annexe 1 Haul positions

red: IGFS, blue: Evhoe



Annexe 2 Number hauls outside grids

Table S1. Number of hauls carried out by Evhoe that are outside the 0.5 x 0.5 and 1° x 0.5° grids (Fig. 1b & c).

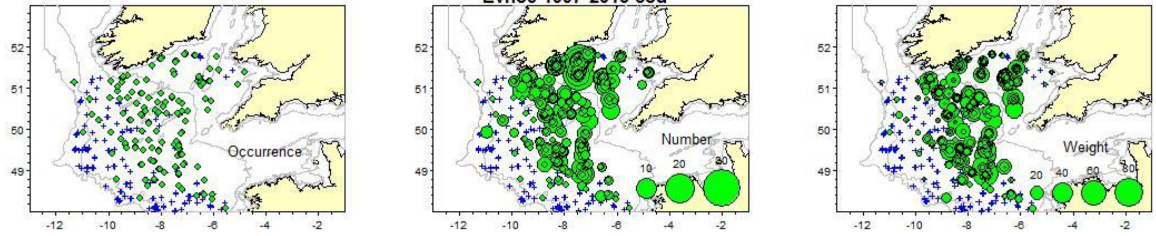
Evhoe stratum	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013
Cc3	2	4	3	3	1	2	2	5	2	0	5	2	1	2	2	1	2
Cc4	9	7	9	6	20	15	16	11	11	13	16	16	13	7	15	12	11
Cc5	2	1	1	0	2	1	2	1	2	2	0	2	2	1	1	2	2
Cc6	2	2	1	1	1	2	1	2	2	2	1	2	2	3	1	1	3
Cc7	0	0	1	0	1	1	1	1	1	1	1	1	1	1	1	1	1
Cn2	0	0	1	0	0	0	0	1	0	0	1	0	0	1	1	1	0
Cn3	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cs4	15	16	15	17	19	20	20	18	20	15	18	18	17	19	17	14	20
Cs5	6	7	6	8	8	10	12	6	9	6	9	10	10	9	10	8	9
Cs6	2	2	2	2	3	3	2	2	3	3	2	3	3	3	3	2	3
Cs7	0	0	2	0	2	2	2	2	2	2	2	2	2	2	3	2	2

Table S2. Number of hauls carried out by IGFS that are outside the 0.5x0.5 and 1 x 0.5 grids (Fig 1 b & c).

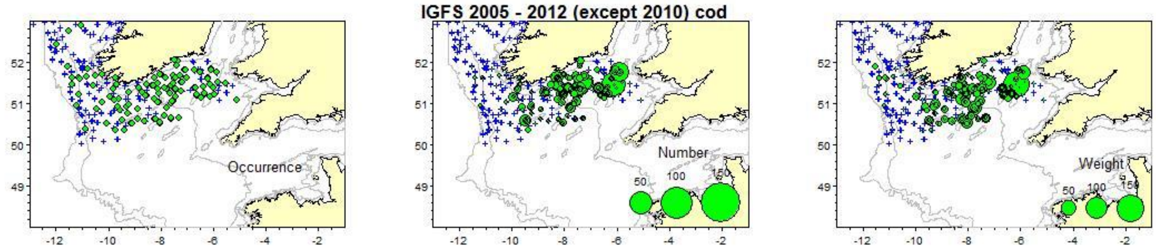
Evhoe stratum	2005	2006	2007	2008	2009	2011	2012
outside	82	99	97	95	102	74	90
Cc4	1	0	3	4	2	4	5
Cc6	1	0	1	1	1	1	2
Cc7	1	0	1	1	0	1	0

Annexe 3 Species maps

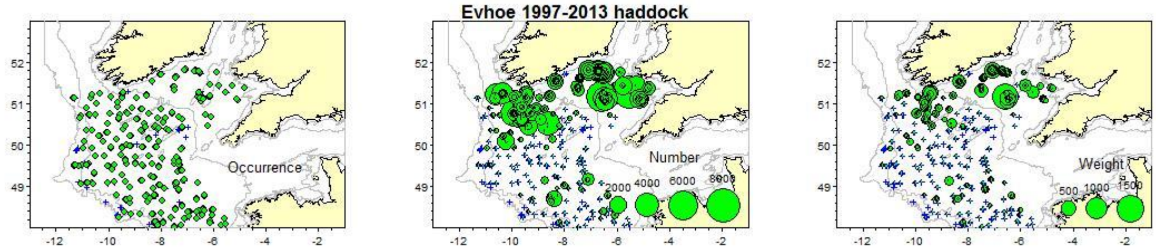
Evhoe 1997-2013 cod



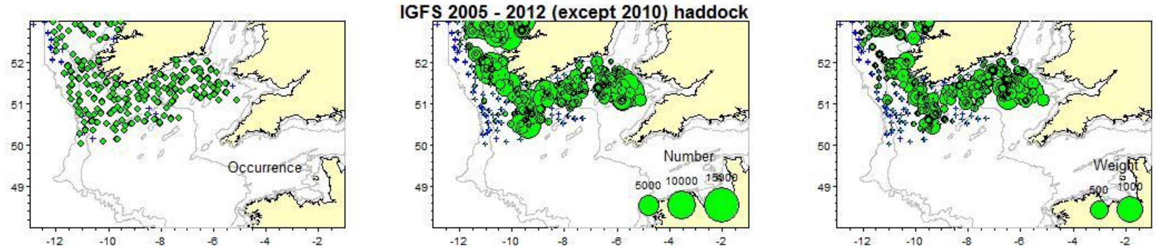
IGFS 2005 - 2012 (except 2010) cod



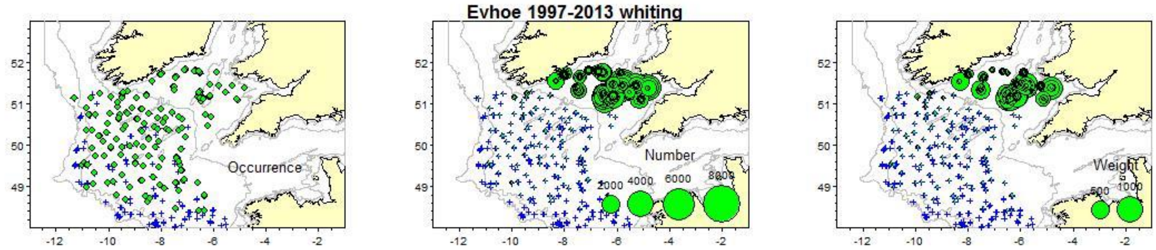
Evhoe 1997-2013 haddock



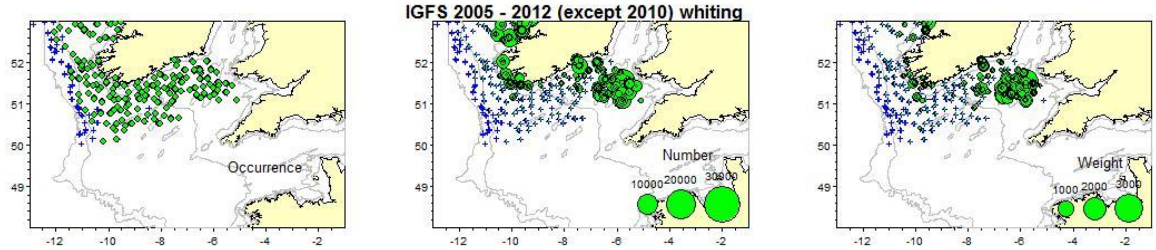
IGFS 2005 - 2012 (except 2010) haddock

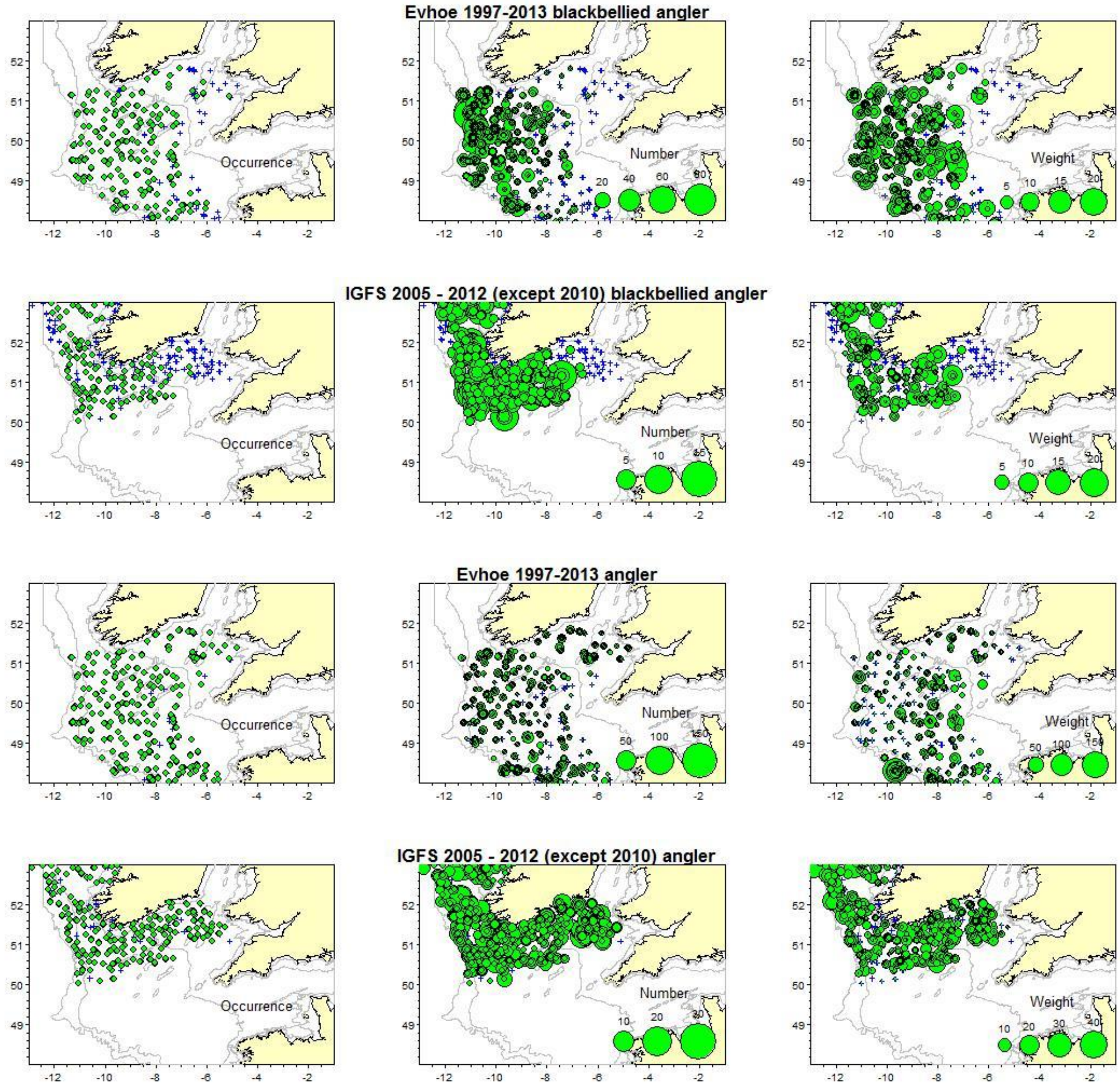


Evhoe 1997-2013 whiting



IGFS 2005 - 2012 (except 2010) whiting




Evhoe 1997-2013 blackbellied angler
Occurrence
Number
20 40 60 80
Weight
5 10 15 20
IGFS 2005 - 2012 (except 2010) blackbellied angler
Occurrence
Number
5 10 15
Weight
5 10 15 20
Evhoe 1997-2013 angler
Occurrence
Number
50 100 150
Weight
50 100 150
IGFS 2005 - 2012 (except 2010) angler
Occurrence
Number
10 20 30
Weight
10 20 30 40

CAMANOC Survey Report

Morgane Travers-Trolet, Yves Vérin

1. Rationale of the survey

As a junction between the Atlantic Ocean and the North Sea, the English Channel is a singular sea hosting a diversified benthic, demersal and pelagic fauna, mostly exploited by French fisheries. Conversely to the eastern part, the western English Channel is a poorly known ecosystem because only few surveys occur in this area. In the context of Ecosystem Approach to Fisheries and following the Marine Strategy Framework Directive (MSFD) recommendations, we need to establish a state of the art of the “western English Channel” ecosystem and to monitor it in the coming years. This can only be achieved by gathering complete data covering a maximum of compartments of this system.

Gathering together researchers of various disciplines and from diverse institutes located along the Channel (several IFREMER laboratories, several French universities, English laboratories, universities and NGO), the CAMANOC survey (Pluridisciplinary survey of western Channel) aims at sampling the entire ecosystem : hydrology, planktonic compartments including fish eggs and larvae, benthic invertebrates, pelagic, demersal and benthic fish and cephalopods, marine birds and mammals. To do so, the entire western English Channel is to be sampled by complementary gears: hydrological probe, niskin bottle, high frequency measurements systems such as Ferry Box, LOPC, plankton nets, GOV trawl, pelagic trawl, grab, dredge, ROV for sub-marine video, multibeam echosounders and visual observations.

After treatment and analysis, the data acquired will be used to describe the species composition of biological assemblages (fish, plankton, benthos), to characterize their habitats and spatial distributions, to understand the food web structure and to establish a set of indicators related to the ecological state and the descriptors from the MSFD. Furthermore, the sampling of particular stations with a set of gears will allow, by comparison with historical data, to determine the impact of climate change on the composition of benthic invertebrates assemblages, which are known to integrate such change.

2. Survey trajectory and sampling stations

The survey aims at sampling the western and central Channel, between longitudes 6°W and 1°E. The R/V Thalassa left Brest on the 15th of September 2014 to sample the western Channel. The vessel stopped at Cherbourg on the 29th and 30th of September 2014, to allow disembarkment of samples and crew rotation. The final stop was in Le Havre, on the 13th of October 2014 after sampling the central Channel.

Due to good weather conditions, a consequent amount of stations was sampled (Figure 1):

- 88 trawls (42 in the western Channel, 46 in the central Channel in parallel with the R/V Gwen Drez)
- 95 stations with measurements of physico-chemical parameters and plankton sampling (mostly associated with trawls but also including L4 and E1 stations in front of Plymouth)
- 185 benthic dredges
- 21 videos realized on the sea floor
- 492 samples of sub-surface zooplankton, in order to get fish eggs

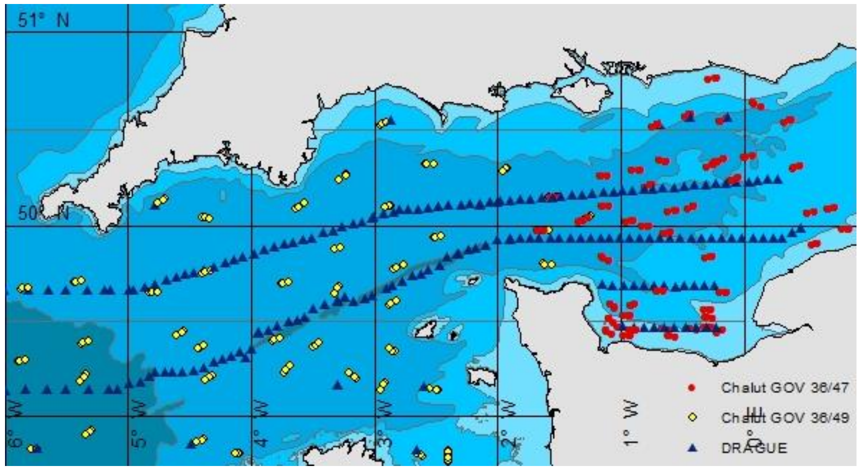


Figure 1: Main stations sampled during the CAMANOC survey. In blue: dredges, in yellow: bottom trawls in the western Channel, in red: bottom trawls in the central Channel

3. Preliminary results

Physico-chemical parameters were recorded continuously at sub-surface during the whole survey, and punctually at each sampled stations. Results (Figure 2) show colder water in the western part of the area, corresponding to the deeper zone and the most influenced by Atlantic Ocean. The salinity is low on the French coast in the eastern Channel, due to the important river outflow of the Seine.

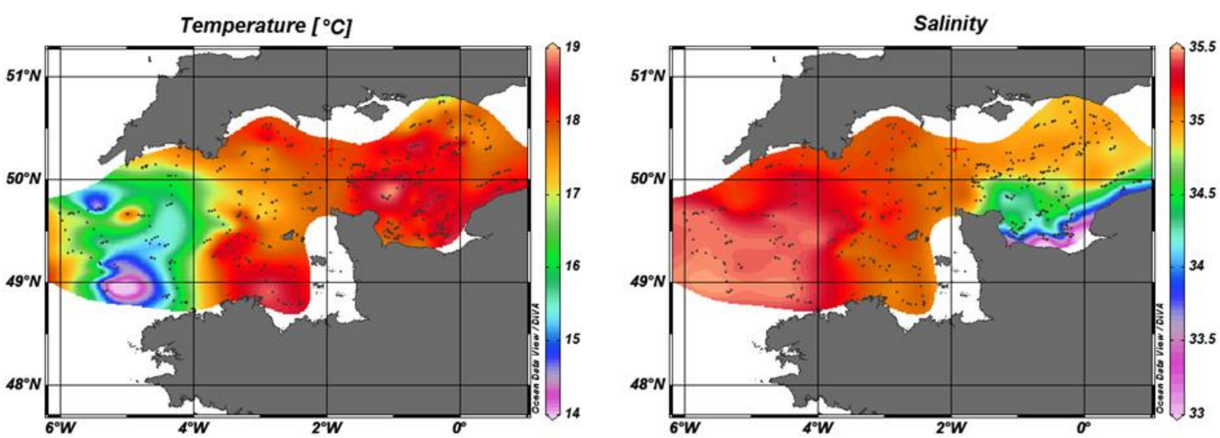


Figure 2: Interpolated temperature and salinity over the area covered with the CAMANOC survey

The fish community of the western Channel has been sampled with a new bottom GOV trawl adapted to the hard bottom of this area (36/49 GOV with TPE net, 'hard-bottom' groundrope and semi-pelagic rigging, Figure 3). The trawl geometry was successfully within the ICES standard values, with a mean vertical opening of 4.74m and a mean wing spread of 20.27m (Figure 4). Furthermore, some megabenthos and flatfish were present in the catch, indicating that the trawl is working adequately in the bottom, and the gear has not be severely damaged during the survey, indicating that this new GOV is well adapted to the hard bottom of the Western Channel.

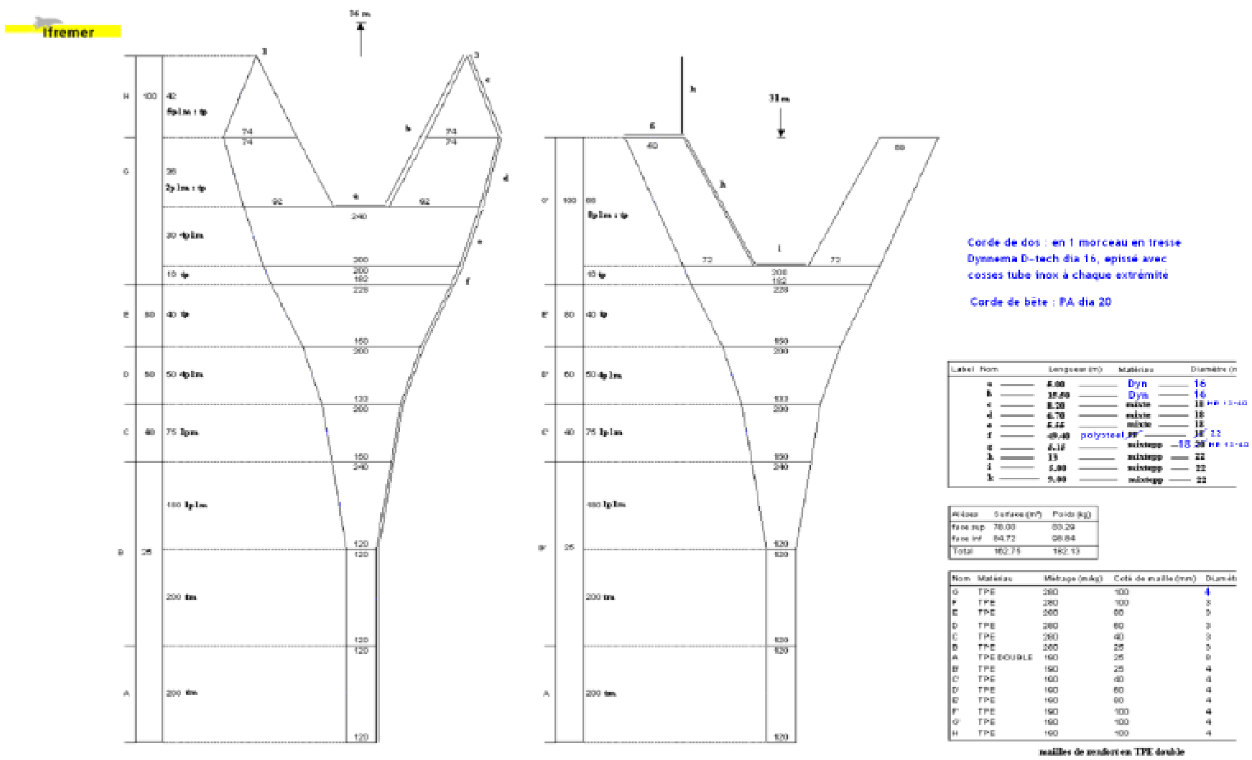


Figure 3: schematic of the 36/49 GOV used during the CAMANOC survey

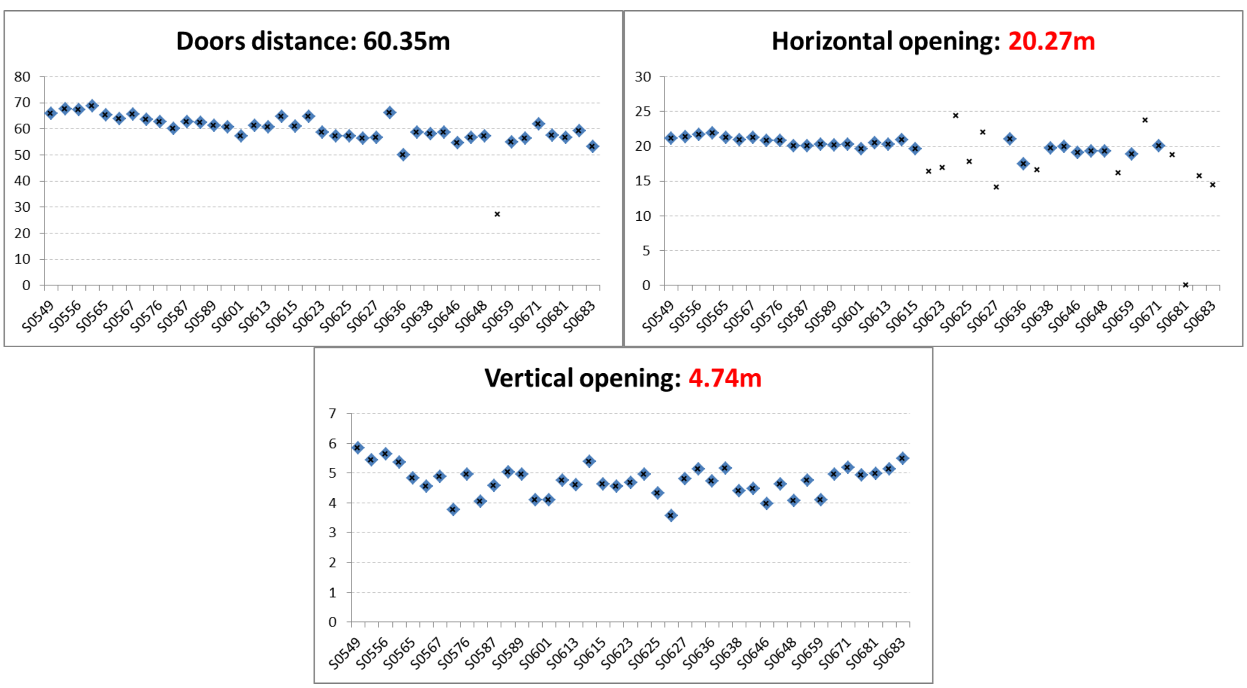


Figure 4: characteristics of the GOV trawl 36/49 used during the first part of the CAMANOC survey in the Western English Channel (41 stations). Blue dots correspond to valid data whereas small grey crosses correspond to problem with sensors resulting in erroneous values that are not taken into account in the mean values of GOV geometry.

The preliminary results concerning the catch are shown in figure 5, and detailed by species of commercial interest in figure 6. Some biological samples have been taken during this survey, including length-weight measurements, otolith samples (Table 1) and maturity determination, and stomach contents for further analyses on fish diets.

Table 1: number of individuals dissected for otolith sampling during the CAMANOC survey in 2014

	7E	7D
Haddock	216	-
Red gurnard	169	95
Whiting	410	201
Pouting	85	97
Anchovy	38	-
Pollack	15	-
Lemon sole	74	37
Dab	20	26

	7E	7D
Seabass	1	40
Megrim	22	-
Hake	22	-
cod	28	14
sardine	101	-
Plaice	50	99
Red mullet	-	58
Sole	7	11

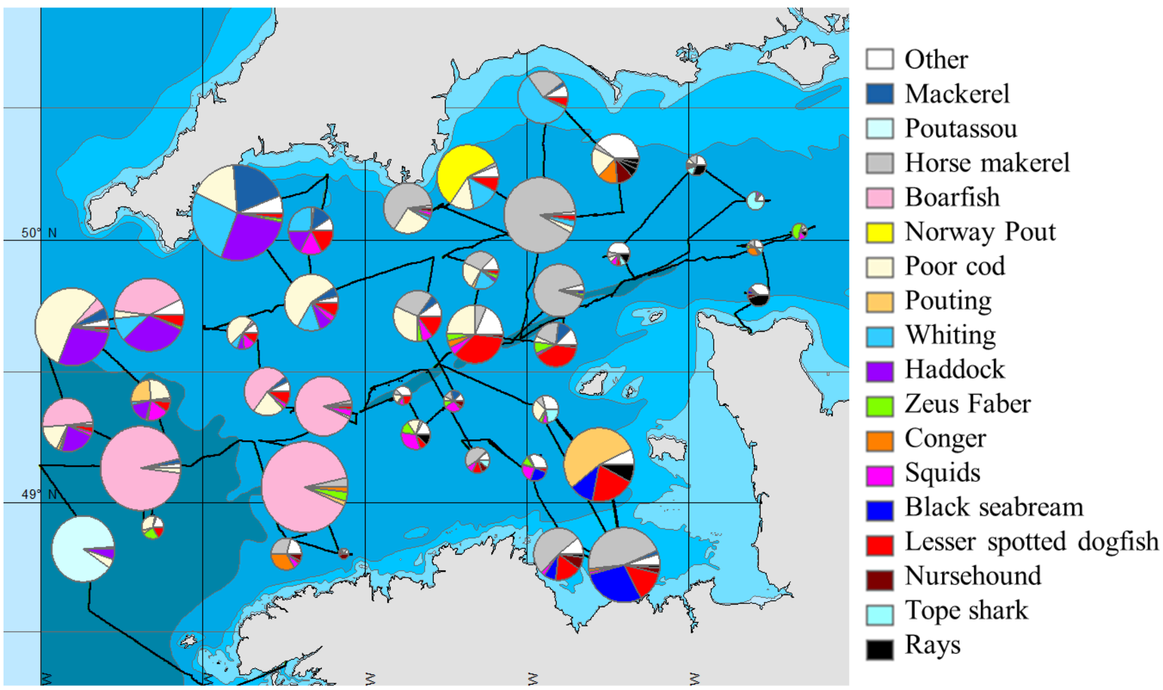


Figure 5: Species composition of the catch in the Western Channel, and relative biomass caught (expressed by the size of the circles)

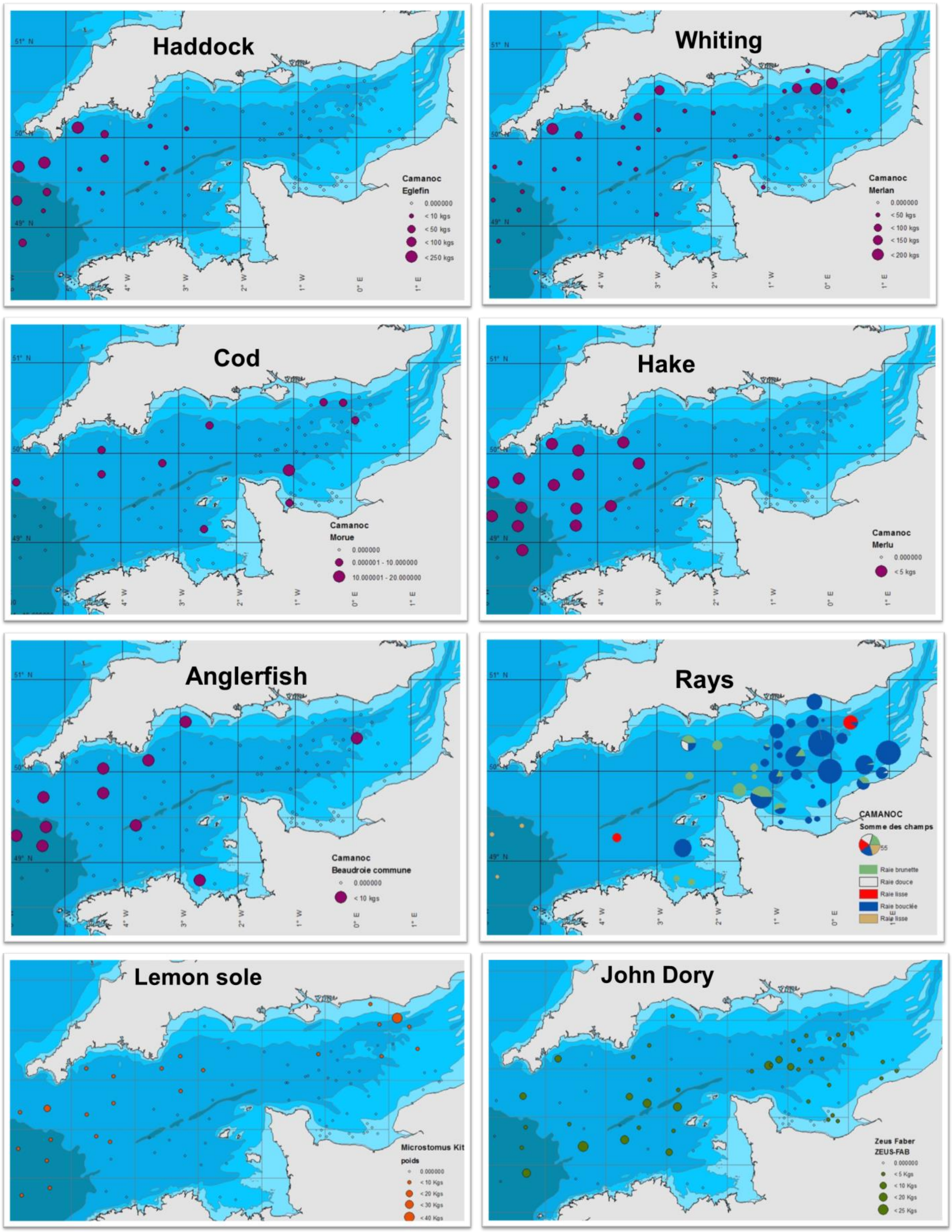


Figure 6: Species catch (in kg per haul) during the CAMANOC survey. On the western part, a type-D GOV gear was used whereas on the central Channel (east of 1.5°W) a type-A GOV gear was used.