Annex 5: Working documents

Working documents HAWG 2019	
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Working Document 01a, HAWG 2019 *17/12/18*

Marine Scotland Science sandeel dredge survey indices for SA4

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Introduction

The Marine Scotland Science (MSS) sandeel survey of SA4, off the north east UK coast, was established in 2008 to complement the Danish dredge survey of areas 1 – 3. The survey is targeted at historically fished banks off the Firth of Forth and around Turbot bank and takes place in late November or early December to coincide with the Danish sampling. All the Firth of Forth banks sampled are within the North East UK sandeel closure, where fishing is currently limited to a monitoring TAC. This report presents the results from the survey for the years 2008 – 2018 and compares the Firth of Forth banks with data from the same stations sampled during research surveys conducted in October-November between 1999 and 2003.

Methods

Dredge hauls encompassing the major Firth of Forth banks were taken at 8 stations in 1999 – 2003; 3 stations on the Wee Bankie, 3 on Marr Bank and 2 on Berwick Bank. In 2008 – 2018, additional stations were sampled over Berwick Bank and around the Wee Bankie grounds. During 2008 – 2013, and 2015 – 2017, Turbot Bank and/or nearby patches of sandeel habitat have also been dredged. The survey in 2018 sampled from 2 stations on Wee Bankie, 3 on Marr Bank and 3 on Berwick Bank. Where possible 5 tows of 10 minute duration were made per station, although time constraints has sometimes reduced this to 3. Weather conditions were severe in 2018 so all 2018 stations were reduced to 3 tows due to time constraints and Turbot Bank was not sampled. All captured sandeels were measured and a length stratified sample was aged to produce average age-length keys for Firth of Forth grounds. Numbers caught were converted to numbers per area swept and then raised to numbers per hour based on the average area swept in one hour. Average CPUE for SA4 was calculated using the averaging method given by Christensen in Appendix A (WKSAN 2010).

Results

The total numbers of hauls by sandeel bank are given in Table 1. Due to the different requirements of surveys, sample sizes were low prior to the establishment of a dedicated recruit survey in 2008. As only sandeels ≥ 8.5 cm TL are fully selected by the gear and many 0-group are typically below this length, age 1 catches are generally higher than age 0 for a given year-class, although this was not the case for the 2012, 2013, 2015, 2016 and 2018 cohorts. Nevertheless, catch rates at age 1 were significantly correlated with age 0 and likewise between catch rates of age 1 and 2 sandeels ($P < 0.01$, Figure 1).

Incoming year-class abundance was much lower compared with last year, marking a break in the trend of increasing recruitment since 2015. This result is concerning as this year's abundance of Age 0 fish is the lowest observed throughout the time series. Age 1 fish densities were elevated, across the Firth of Forth, with capture rates the third highest observed throughout the time series. In the southerly stations, frequency distributions were dominated by 1-group fish of size 9 to 12 cm. This high age 1 abundance is consistent with last year results, seemingly as a consequence of large 0-group abundance in 2017 (Figure 2). This result suggests low recruitment to the Southern part of SA4.

Table 1. Scottish dredge survey. Number of hauls by sandeel bank and year.

Bank	Year													
	1999	2000	2001	2002	2003	2008	2009	2010	2011	2012	2013	2014	2015	2016
Wee Bankie	3	4	3	3	3	18	15	18	11	14	18	16	18	20
Marr Bank	4	5	3	3	3	8	8	9	7	7	13	10	6	11
Berwick Bank	2	5	0	2	2	6	8	8	6	6	17	14	20	16
Turbot Bank	0	0	0	0	0	3	15	16	17	20	6	0	16	35

Bank	Year													
	2017	2018												
Wee Bankie	16	7												
Marr Bank	9	9												
Berwick Bank	9	9												
Turbot Bank	24	0												

Table 2. Average CPUE by age for a) SA4 and b) Firth of Forth

a)				b)		
Year	Age 0	Age 1	Age 2	Age 0	Age 1	Age 2
1999				615	494	301
2000				586	3170	258
2001				48	2656	1561
2002				243	404	916
2003				580		
2008	52	24	18	68	24	24
2009	832	87	38	1023	174	56
2010	147	1032	67	186	1244	78
2011	89	165	407	119	220	534
2012	95	135	23	122	178	30
2013	62	85	35	82	89	45
2014	445*	43*	12*	445	43	12
2015	136	1044	14	151	1126	13
2016	300	81	90	163	98	105
2017	346	223	40	438	235	50
2018	16*	461*	91*	16	461	91

*Adverse weather conditions in 2014 and 2018 precluded any sampling of SA4 stations outside the Firth of Forth region, hence CPUE estimates are identical.

Figure 1: Internal consistency plot. Average CPUE of consecutive ages from the same year-class for Firth of Forth samples. Symbols coloured in red indicate 2018 points.

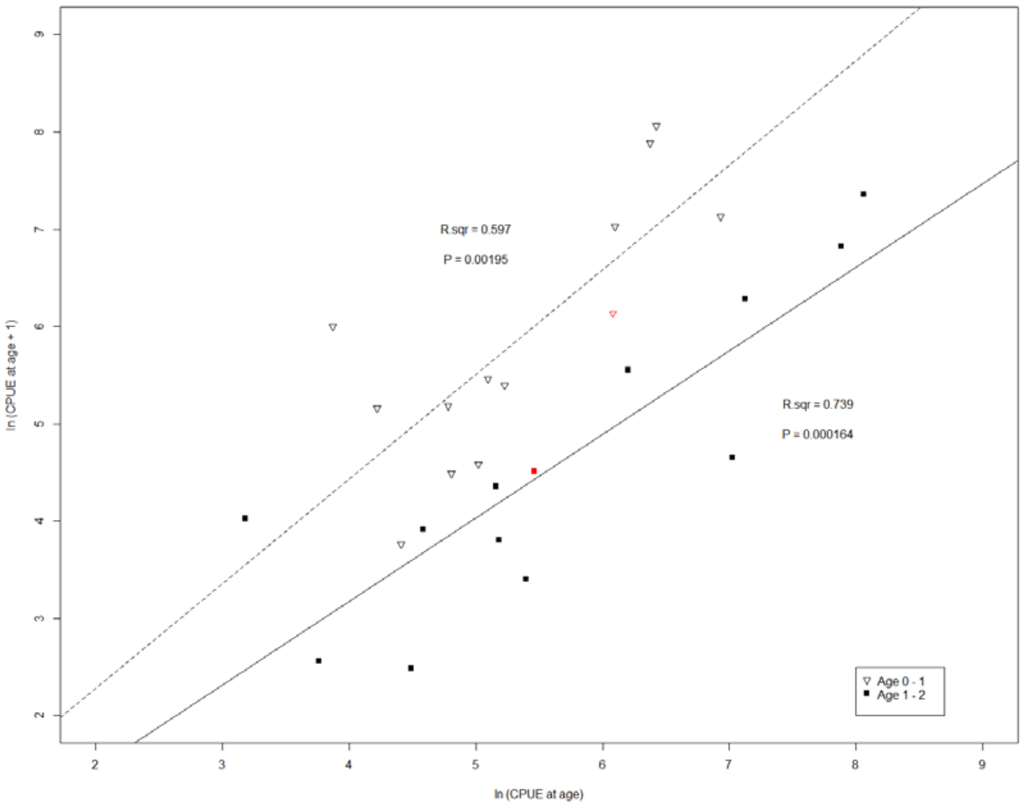
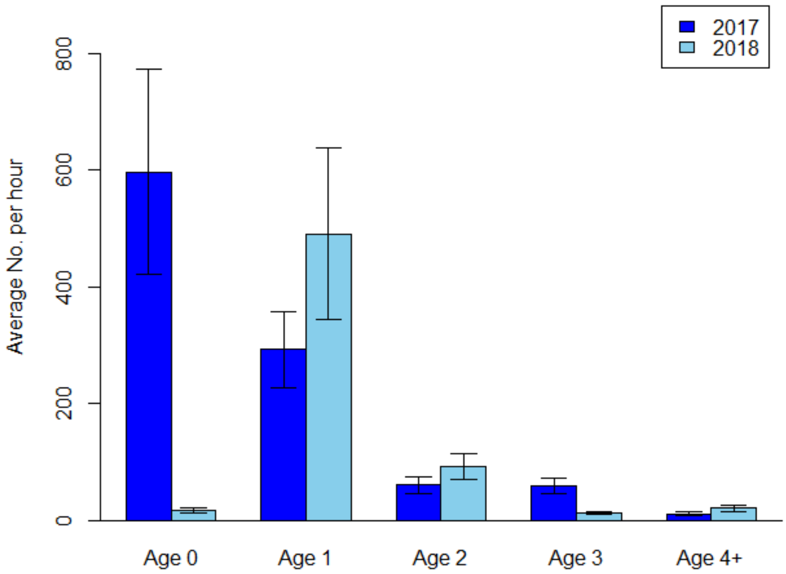


Figure 2: Average catch per hour per age-class in the Southern (Firth of Forth) region compared to last year (2017). Whiskers indicate standard deviation around the mean.



WD 01b

Survey Index Calculations for Western Baltic Spring Spawning Herring from IBTS and BITS data

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March 14, 2019

1 Introduction

This document describes the calculation of standardized survey indices of abundance for Western Baltic Spring Spawning Herring using combined IBTS and BITS data and the methodology of [2]. There is however two extra modelling steps needed for this stock, which consist of splitting the survey length and age data by stock using subsamples of stock-identified individuals.

2 Data Exploration / Filtering

Only data from the year 2002 and onwards are considered, because the data-series for stock splitting from IBTS starts in 2002.

2.1 IBTS

All IBTS data in IIIa with "HaulVal" code "V" and "StdSpecRecCode" equal to 1 are used.

2.2 BITS

All data from areas 20–24, only hauls with "HaulVal" code "V", "A" and "C" are included in the analysis, and also only hauls with "StdSpecRecCode" equal to 1 or 3. The "TVL" gear is excluded also since there are few hauls with this gear type in the area of interest.

3 Stock splitting

3.1 Lengths

Length distributions from IIIa (north of 56 degrees latitude) are split into spring-, autumn-, and winter spawners using split samples from IBTS, and only the spring spawners are used in the further analysis. Longitude and latitude coordinates were unfortunately not directly available in the data

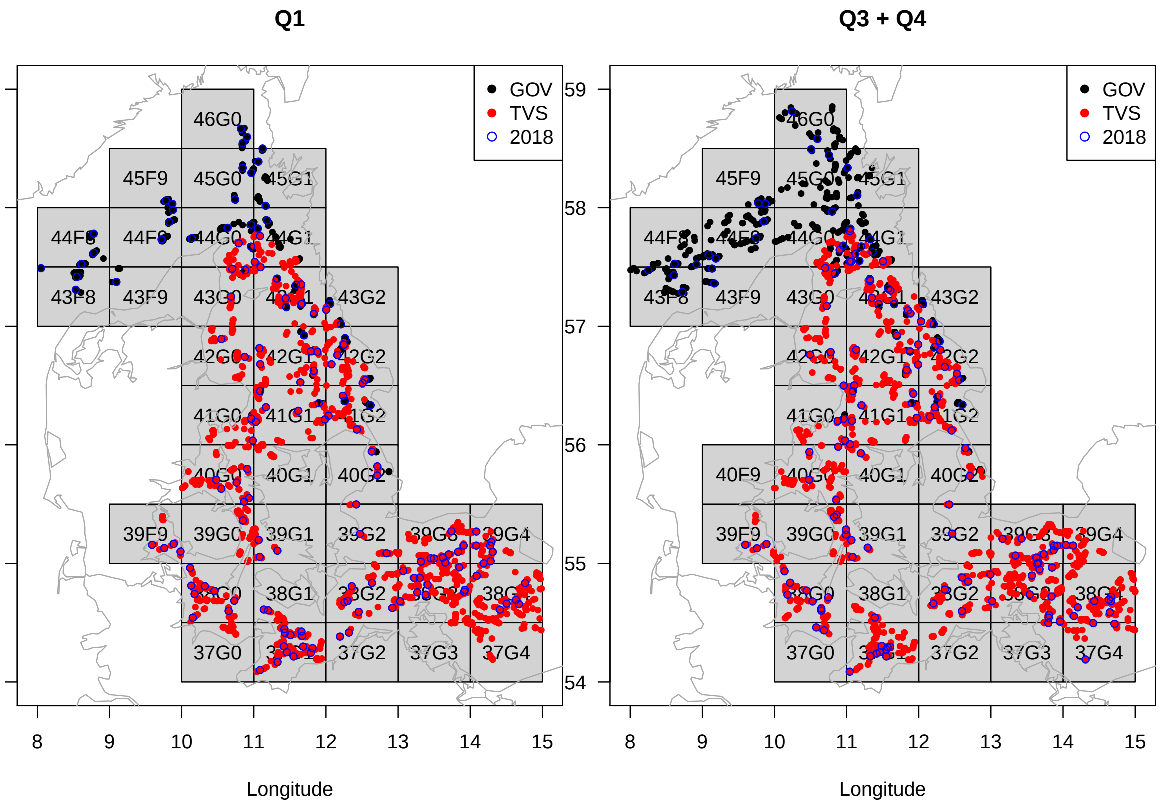

Figure 1: All hauls used in the analysis colored by gear type

set used, but ICES rectangle was, so the midpoint of the ICES rectangle was used instead. Length distributions south of IIIa are assumed to be 100% spring spawners, because there were no split samples from the BITS survey available for the analysis. The probability of belonging to one of the three stock types is modelled as a smooth 4D function of time, spatial coordinates, and length of the fish using a multinomial likelihood

$$stock \sim f(time, lon, lat, length)$$

. The probabilities are calculated by haul and the length distributions are multiplied with the probability of being a spring spawner. In Q1 44% of the total numbers-at-length are estimated to be spring-spawners. In Q3+Q4 it is 39%. See appendix for some predictions from the model.

	4	9	12
4	0.78	0.18	0.04
9	0.23	0.71	0.06
12	0.42	0.05	0.53

Table 1: Cross-classification table

3.2 Ages

The age-samples are also split by stock, using a similar model, although here the model utilizes age and cohort effects as well, since these additional variables are useful for classification, i.e.

$$stock \sim Age + Year + f(time, lon, lat, length) + f(cohort) + f(Year : Age)$$

where Age is truncated to age 5+ to reduce the number of parameters. The first 4D smoother is a tensor product spline of continuous variables, whereas the last two are categorical variables such that a smooth implies Gaussian random effects with mean zero. Each age sample is weighted with the probability of being a spring spawner prior to estimation of ALKs and the age-conversion described in the following section.

	4	9	12
4	0.86	0.10	0.04
9	0.13	0.81	0.06
12	0.41	0.09	0.50

Table 2: Cross-classification table, age specific model

4 ALKs

Smooth age length keys are estimated using the methodology described in [1] using an assumption of a spatially constant relationship, but estimated separately for each combination of year and quarters. The assumption of spatial homogeneity was made because age samples of herring are only available in the IBTS data but not in the BITS data. This implies that the ALK must be extrapolated to the southern part of the assessment area which is only covered by BITS. Numbers-at-age are then calculated using the observed numbers-at-length and the estimated ALKs. The estimated ALKs are shown in the appendix.

5 Survey Indices

Survey indices by age and area are calculated using the methodology described in [2].

The following equation describes the model considered for both the presence/absence and positive parts of the Delta-Lognormal model:

$$\begin{aligned} g(\mu_i) = &\text{Year(i)} + \text{Gear(i)} + f_1(\text{lon}_i, \text{lat}_i) \\ &+ f_2(\text{Depth}_i) + f_3(\text{time}_i) + \log(\text{HaulDur}_i) \end{aligned}$$

where Gear(i) and Year(i) maps the ith haul to categorical gear/year effects for each age group. An offset is used for the effect of haul duration ($HaulDur$), i.e. the coefficient is not estimated but taken to be 1. f_1 is a 2D thin-plate spline for space, f_2 is a 1-dimensional thin plate spline for the effect of bottom depth, and f_3 is a cyclic cubic regression spline on the time of day (i.e. with same start end end point).

The function g is the link function, which is taken to be the logit function for the binomial model. Each combination of quarter age group are estimated separately. The fitted models are then used to sum the expected catches over a fine grid by year and age to obtain the survey index. Nuisance variable such as gear, time-of-day and haul duration are corrected for in this process.

The whole procedure consists of the following steps:

1. Fit a multinomial model to predict probability of WBSS given time, position, and length using individual samples of stock from IBTS.
2. Multiply observed length distributions by haul with predicted stock probabilities to filter out all but WBSS.
3. Fit a multinomial model to predict probability of WBSS given same data and predictors as in step 1, but also include age and cohort.
4. Fit ALK using aged individuals, but weight each age sample with probability of being WBSS using the model from step 3.
5. Apply ALK to WBSS specific length distributions from step 2 and fit survey index standardization model for numbers-at-age by age and quarter
6. Select grid of haul positions
7. Predict abundance on grid by year (using reference vessel, time-of-day etc).
8. Sum of grid points = index

Steps 1 and 2 splits the *length* distributions by haul into WBSS / non-WBSS. Step 3 and 4 splits the individual *age* samples into WBSS / non-WBSS. This is gives us the stock-specific ALK which we can use to convert the split length distributions from steps 1 & 2 into numbers-at-age by haul.

6 Results

The results show that the youngest (immature) age groups are distributed in Kattegat and the Danish Belts, whereas older herring are more predominant in the Sound (Øresund) and the Arcona Basin in the south-east. The distributions are similar in both quarters, although a slightly more north-eastern distribution in Q3 and Q4 compared to Q1. The internal and external consistencies (a measure between 0 and 1 of how well we can "follow the cohorts" within and between surveys under the assumption of constant mortality) are fairly good up to and including age 3, but poor hereafter. This is not surprising considering that the older age groups are mainly distributed in the area south of Kattegat where there are no age samples. I recommend that only indices for ages 0–3 are used in the assessment. It could be considered to obtain commercial age (and split) samples from the areas not covered by the IBTS samples to supplement the ALK estimation. This could potentially improve the indices of the older herring.

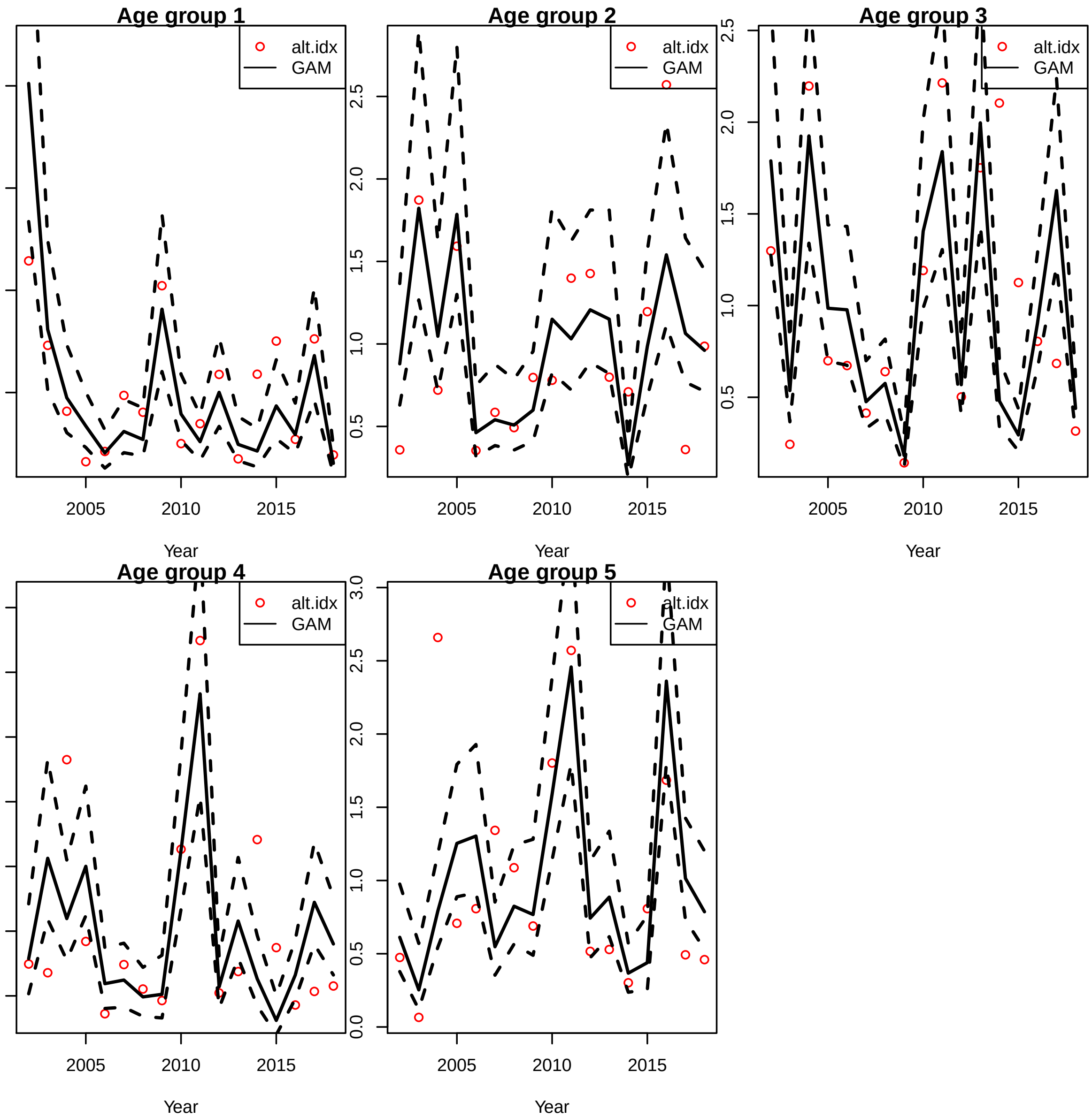

Figure 2: Q1 scaled indices (divided by their mean) by age group (which is the same as age in Q1). Stratified mean method is shown in red.

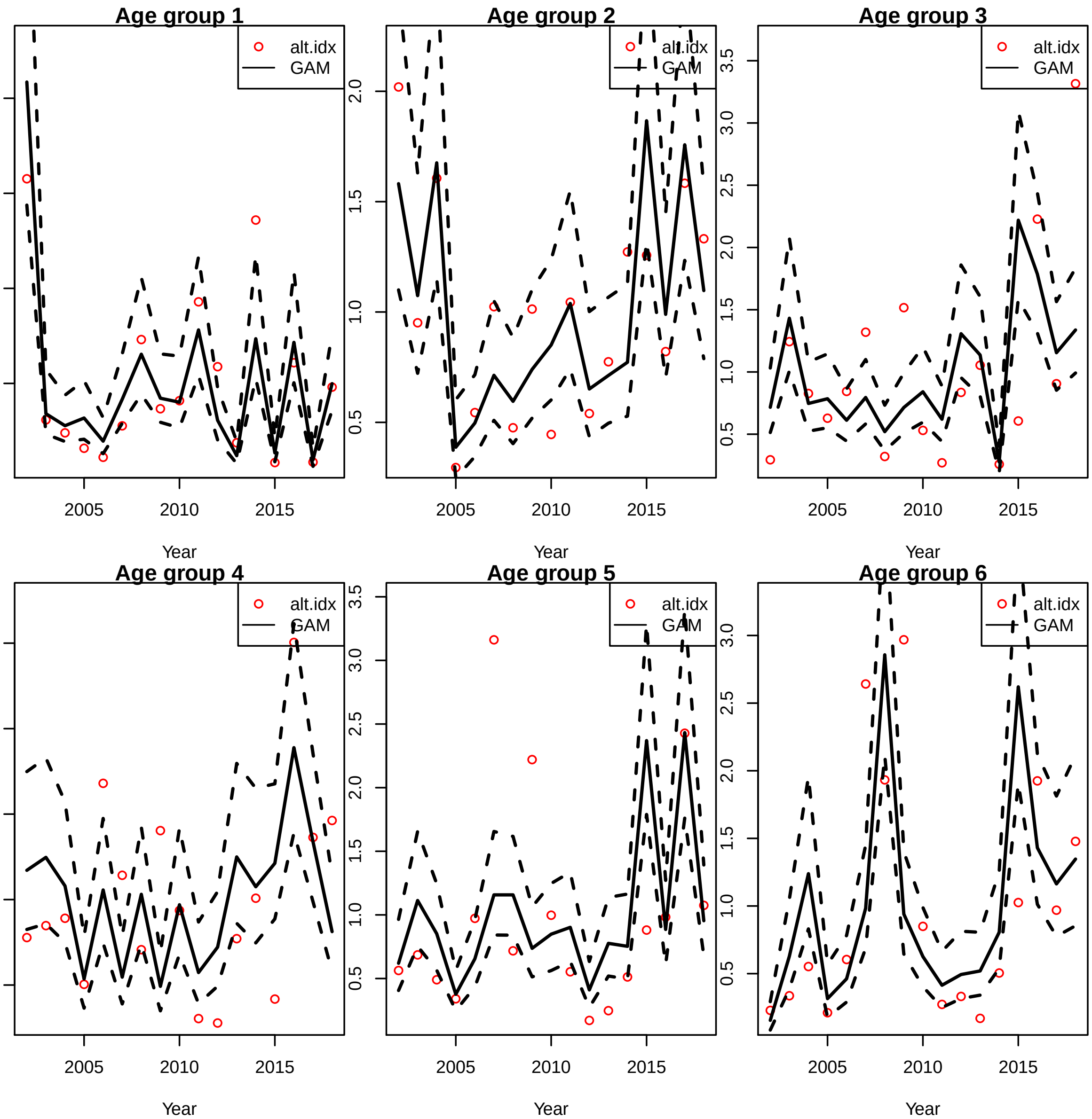

Figure 3: Q3 + Q4 scaled indices (divided by their mean) by age group (which is age - 1 in Q3+Q4 because first age group is 0). Stratified mean method is shown in red.

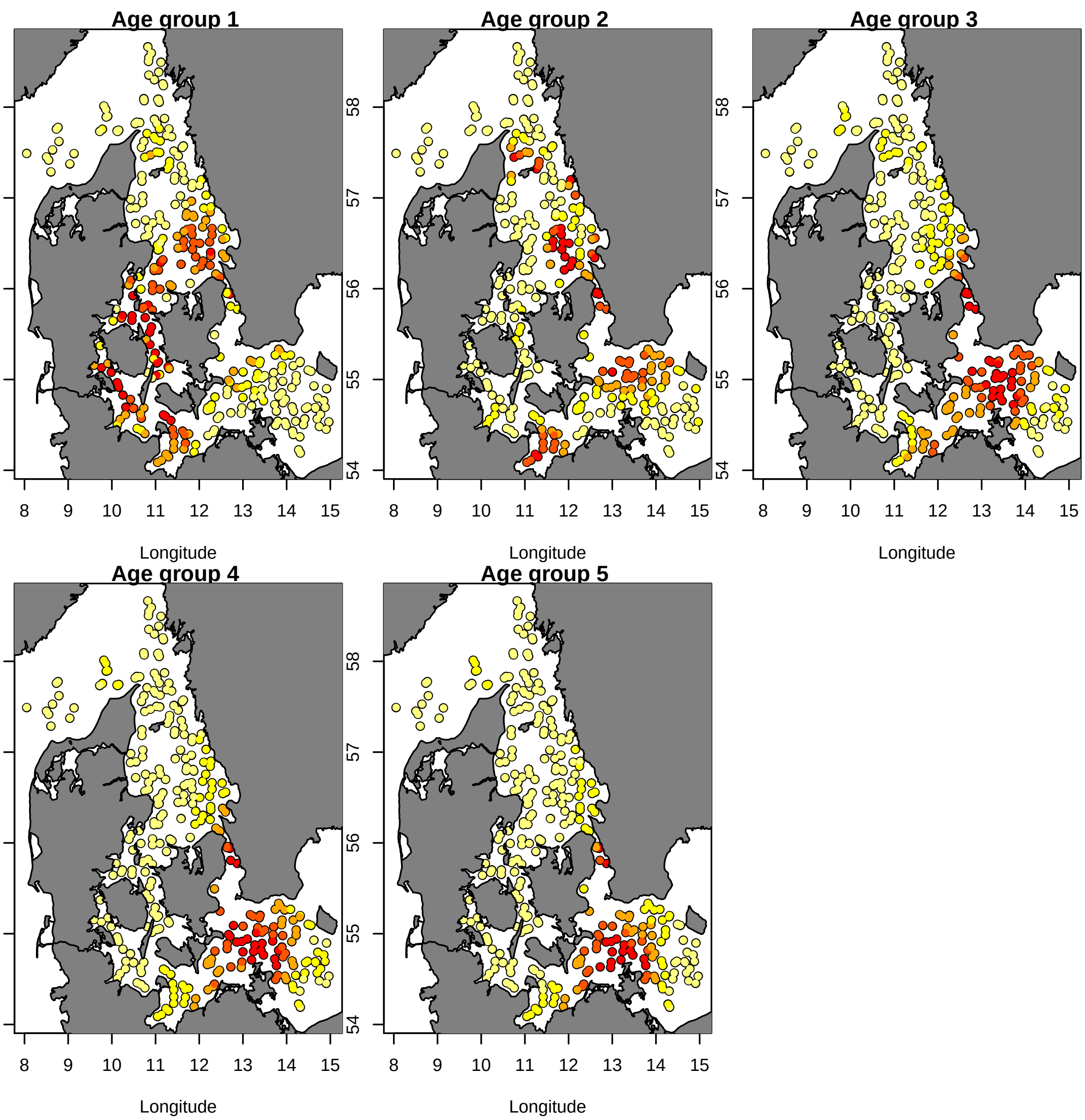

Figure 4: Distribution maps by age group Q1.

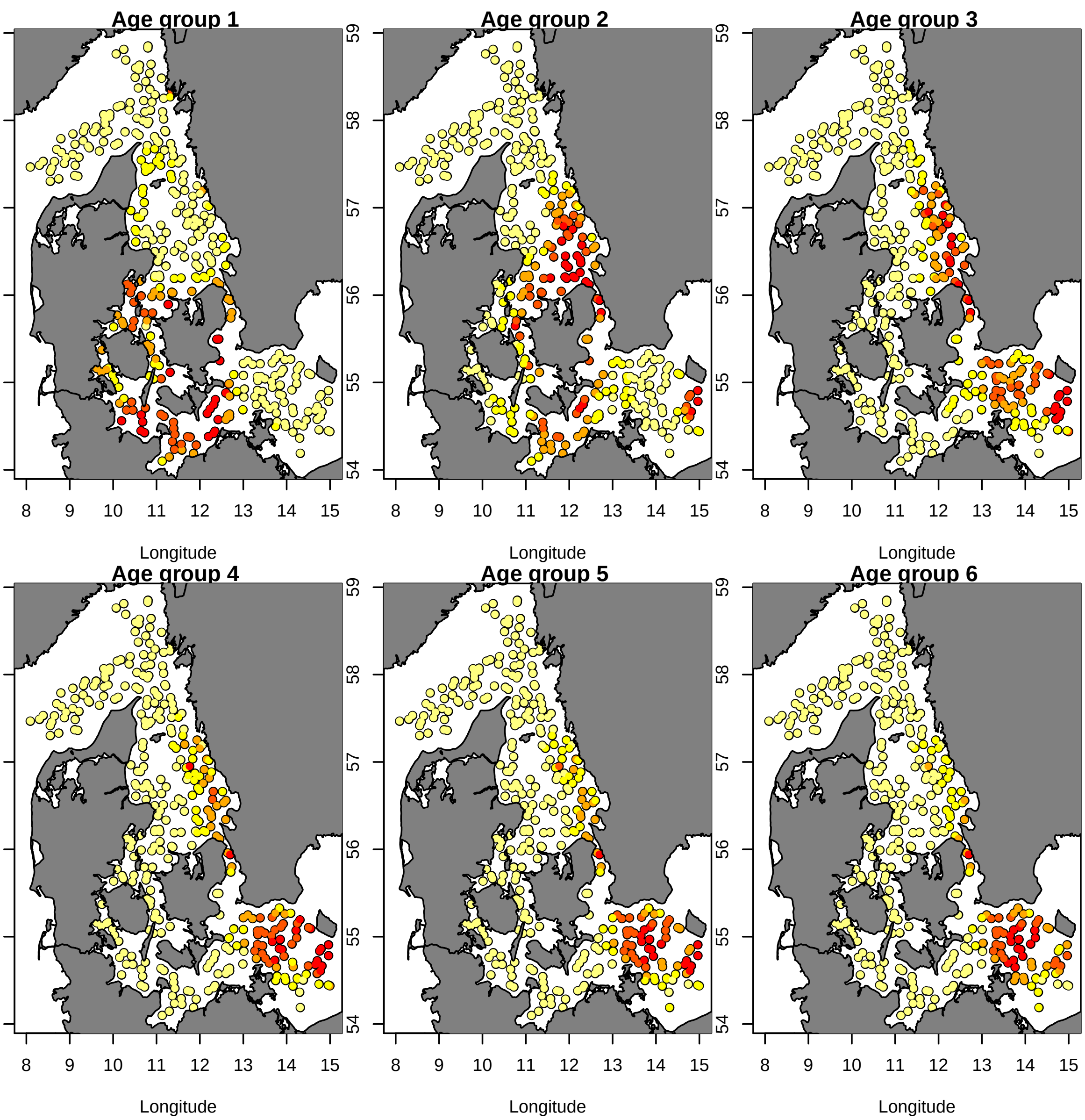

Figure 5: Distribution maps by age group Q3+Q4 (note that age group 1 is age 0).

6.1 Internal and external consistencies

```
> cat("IC Q1:\n")
IC Q1:

> internalCons(SI$idx)
Age  1  vs  2  :  0.5742609
Age  2  vs  3  :  0.6571229
Age  3  vs  4  :  0.1727792
Age  4  vs  5  :  -0.05646259
[1]  0.57426092  0.65712294  0.17277920 -0.05646259

> cat("IC Q3+Q4:\n")
IC Q3+Q4:

> internalCons(SIQ34$idx)
Age  1  vs  2  :  0.2144529
Age  2  vs  3  :  0.4708503
Age  3  vs  4  :  0.4816305
Age  4  vs  5  :  0.4195899
Age  5  vs  6  :  0.4817922
[1] 0.2144529 0.4708503 0.4816305 0.4195899 0.4817922

> cat("EC Q1 vs Q34 same age:\n")
EC Q1 vs Q34 same age:

> externalCons(SI$idx, SIQ34$idx[,-1])
Survey 1 Age  1  vs Survey 2  1  :  0.4312561
Survey 1 Age  2  vs Survey 2  2  :  0.7210529
Survey 1 Age  3  vs Survey 2  3  :  0.3088495
Survey 1 Age  4  vs Survey 2  4  :  -0.152079
Survey 1 Age  5  vs Survey 2  5  :  -0.1277546
[1]  0.4312561  0.7210529  0.3088495 -0.1520790 -0.1277546

> cat("EC Q34 vs Q1 a+1:\n")
EC Q34 vs Q1 a+1:

> externalCons(SIQ34$idx[-nrow(SIQ34$idx),1:5], SI$idx[-1,1:5])
Survey 1 Age  1  vs Survey 2  1  :  0.8028965
Survey 1 Age  2  vs Survey 2  2  :  0.7144539
Survey 1 Age  3  vs Survey 2  3  :  0.5950734
Survey 1 Age  4  vs Survey 2  4  :  0.1321415
Survey 1 Age  5  vs Survey 2  5  :  0.2309258
[1] 0.8028965 0.7144539 0.5950734 0.1321415 0.2309258

> sink()
```

7 Appendix

7.1 Figures

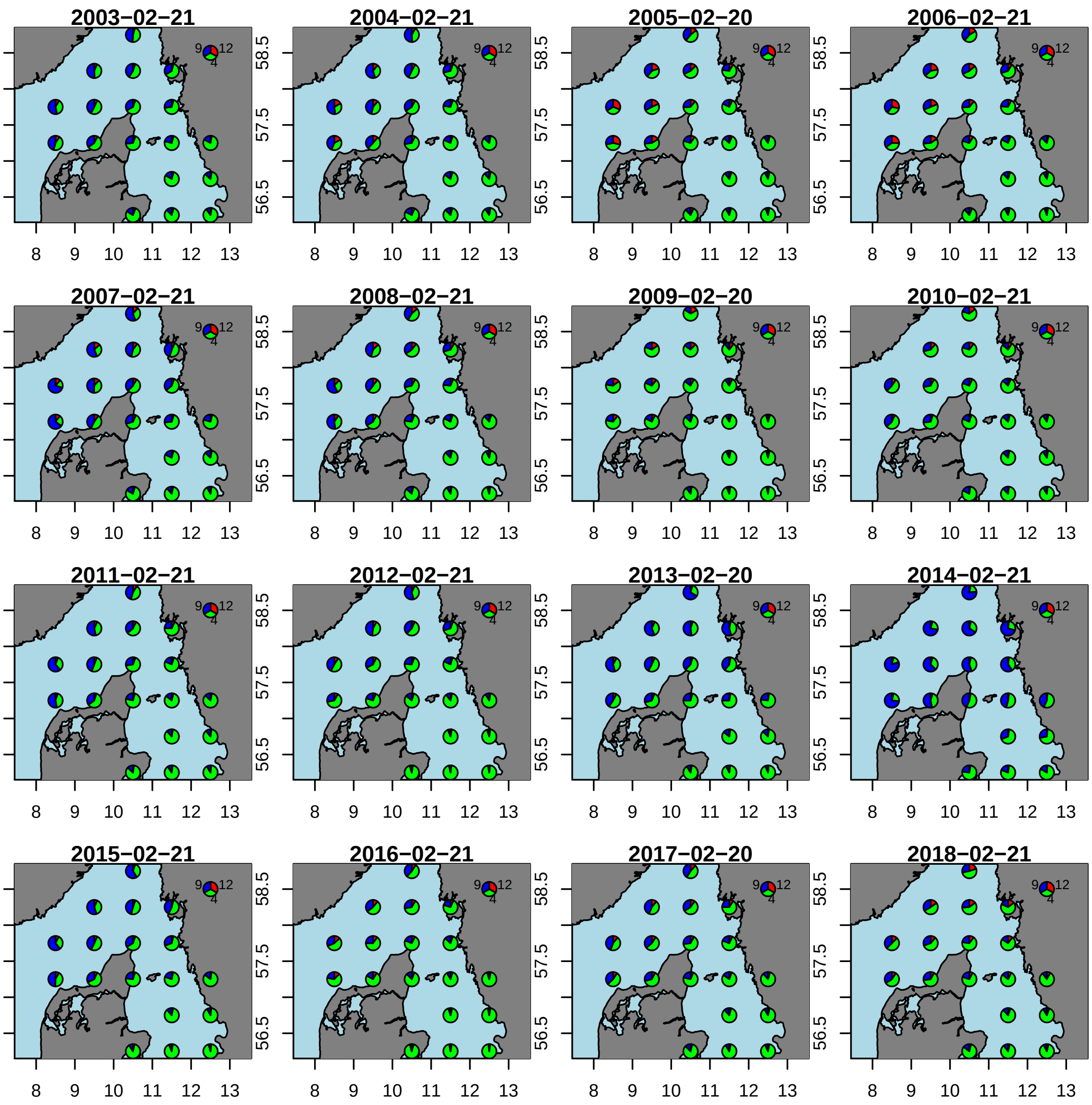

Figure 6: Fitted stock proportions for a 21.5 cm herring (median) by ICES rectangle Q1. Colors denote hatch-month – green is spring-spawners.

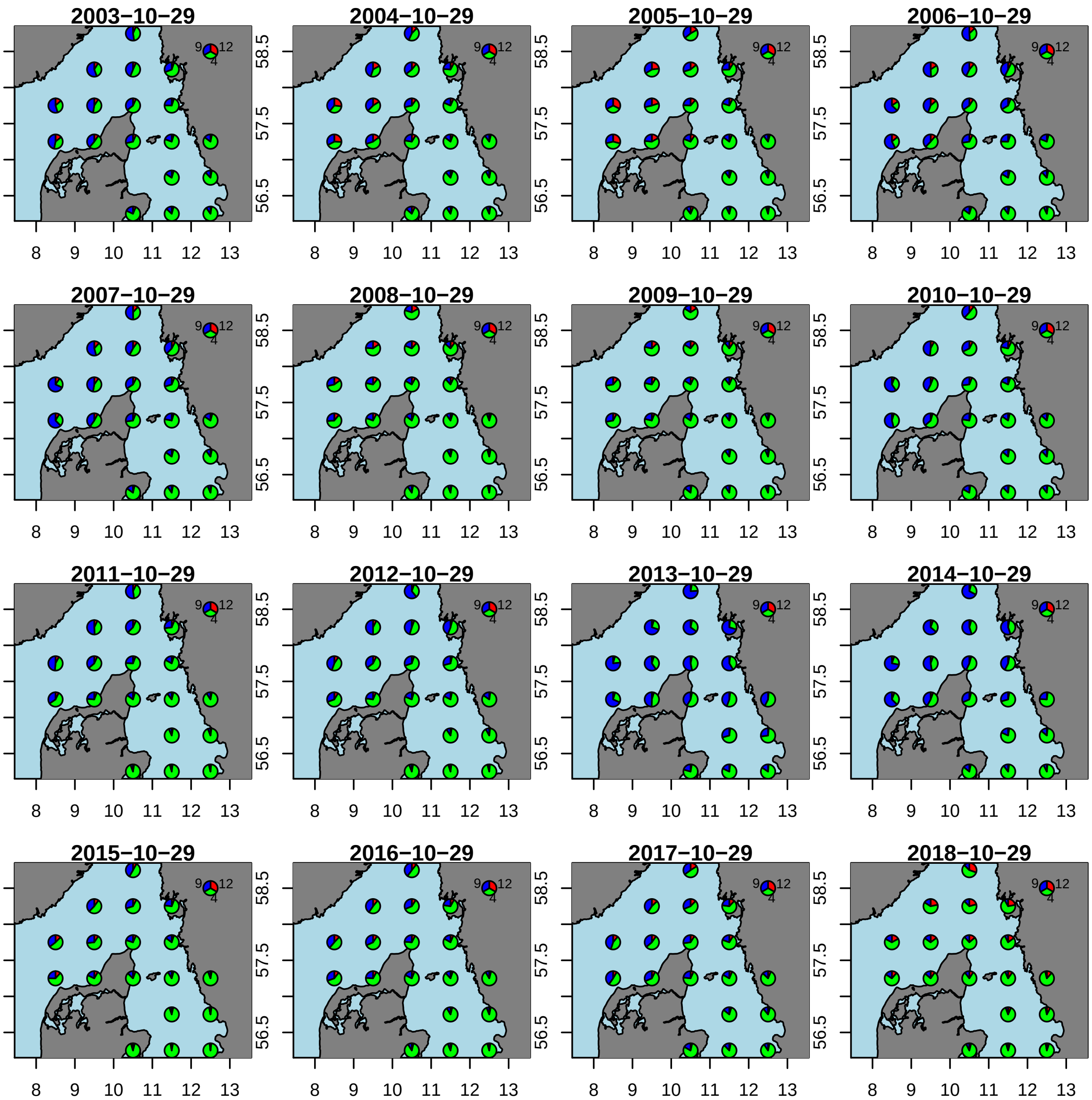

Figure 7: Fitted stock proportions for a 21.5 cm herring (median) by ICES rectangle Q3 + Q4

References

[1] Casper W Berg and Kasper Kristensen. Spatial age-length key modelling using continuation ratio logits. *Fisheries Research*, 129:119–126, 2012.

[2] Casper W Berg, Anders Nielsen, and Kasper Kristensen. Evaluation of alternative age-based methods for estimating relative abundance from survey data in relation to assessment models. *Fisheries Research*, 151:91–99, 2014.

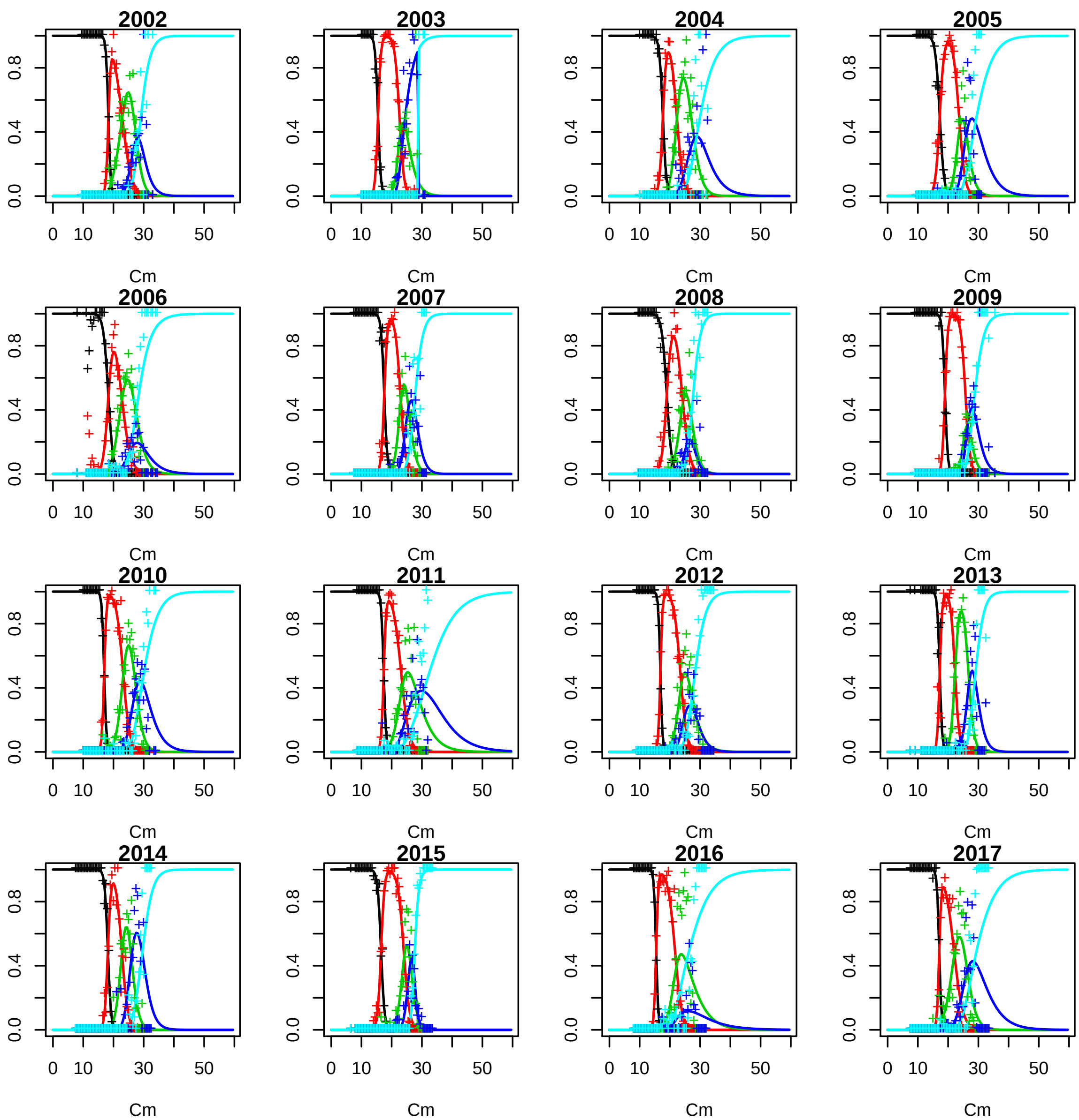

Figure 8: Fitted ALK Q1

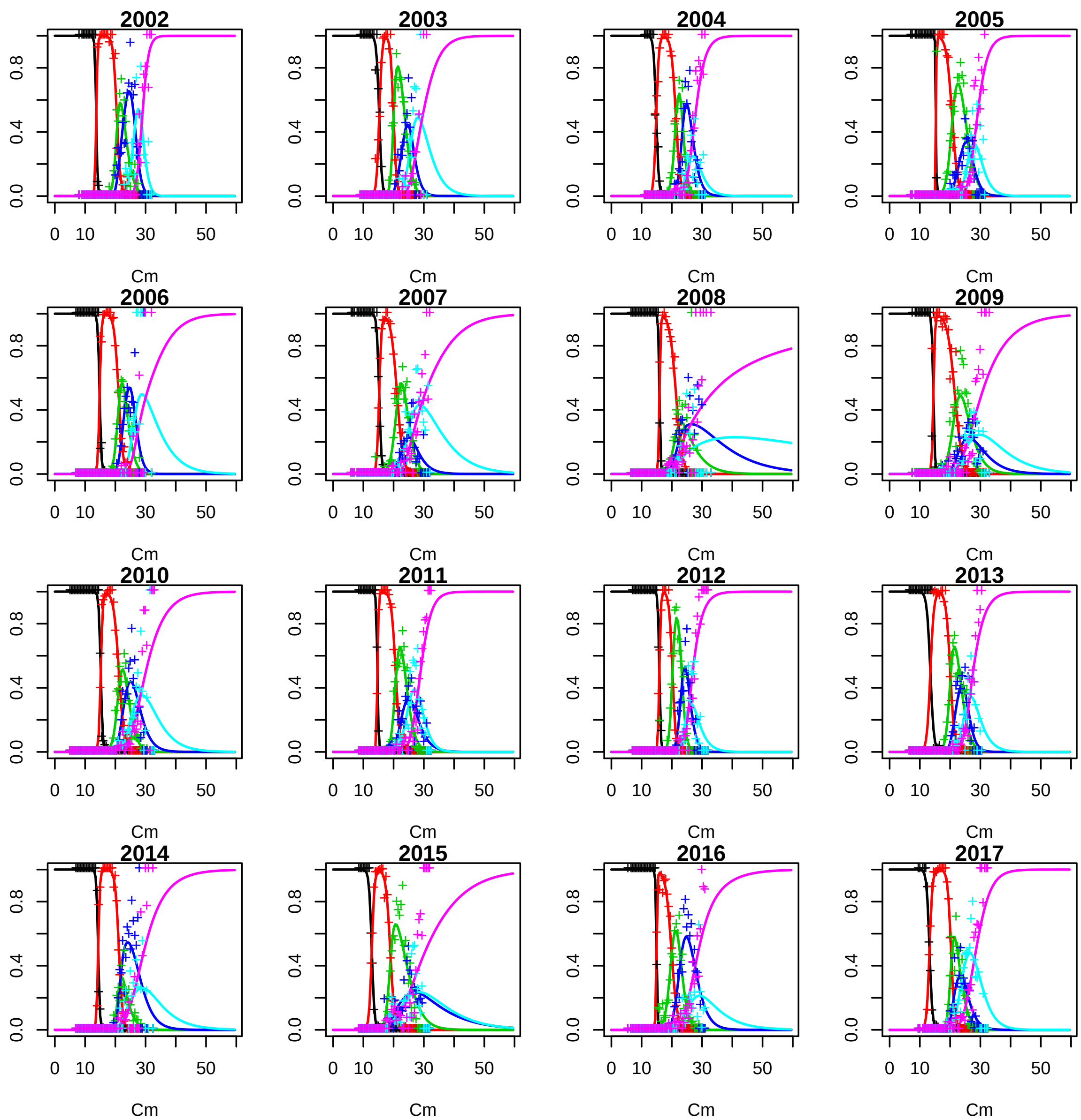

Figure 9: Fitted ALK Q3 + Q4

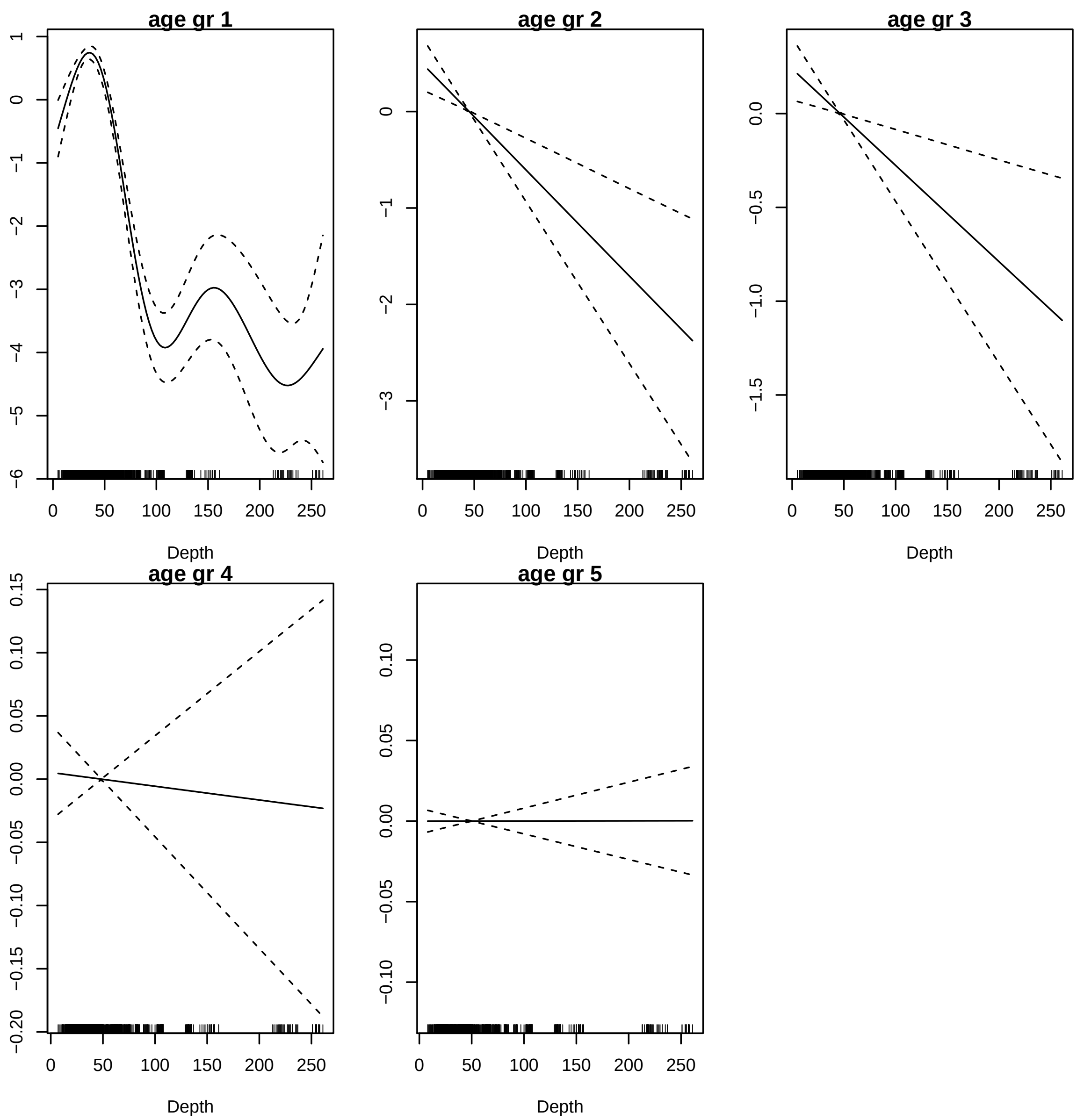

Figure 10: Estimated depth effects Q1

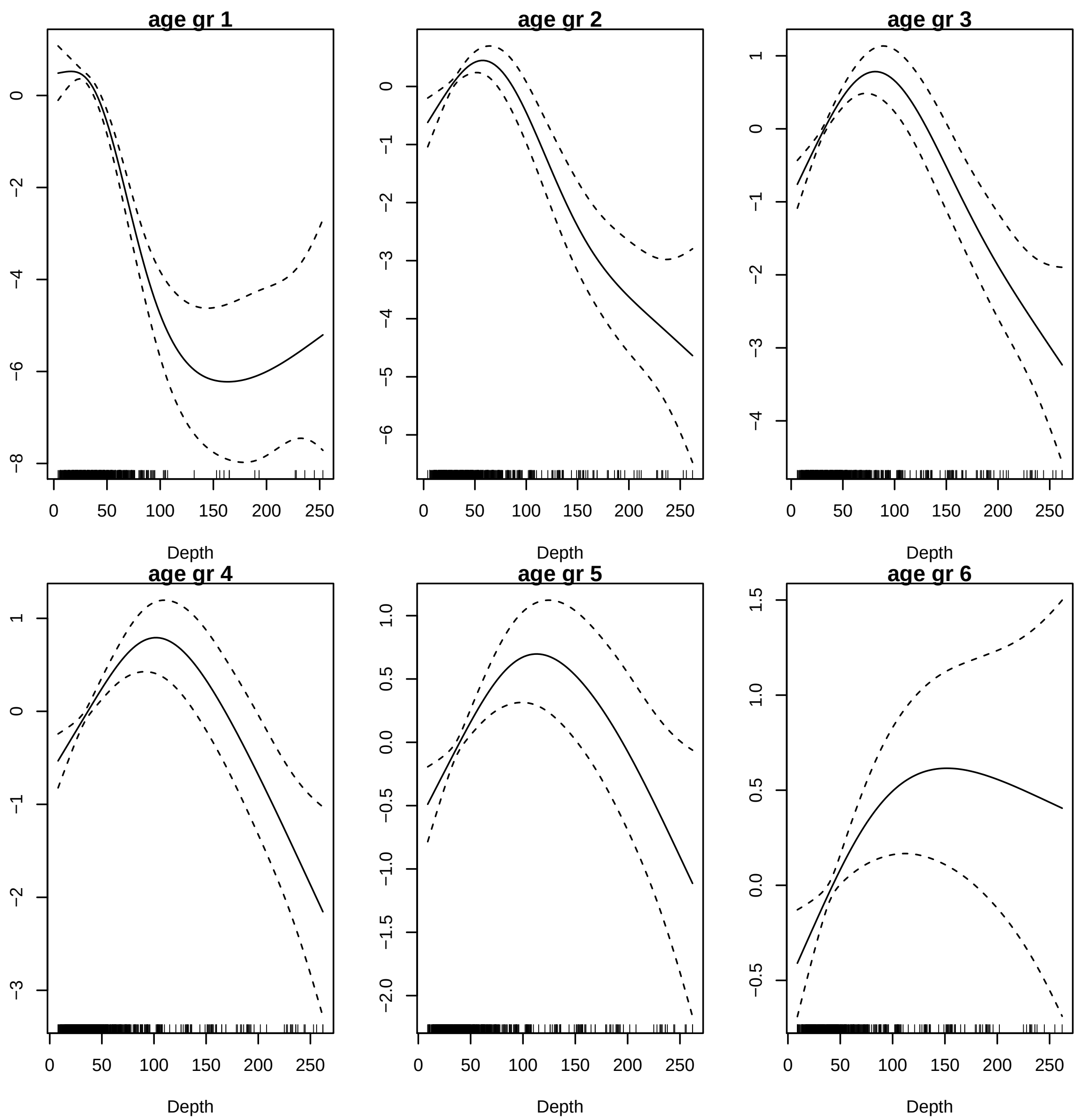

Figure 11: Estimated depth effects Q3+Q4

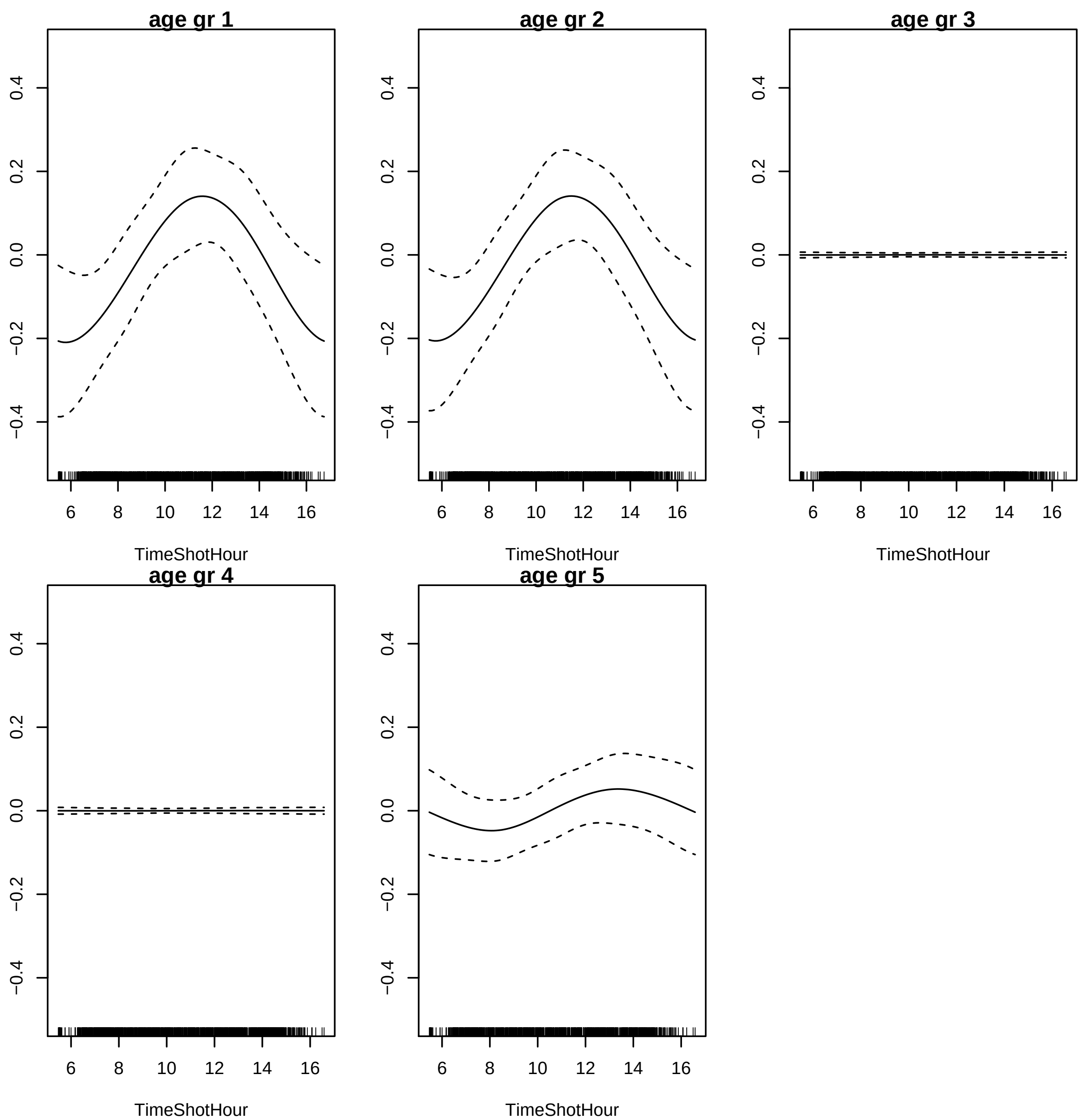

Figure 12: Estimated time of day effects Q1

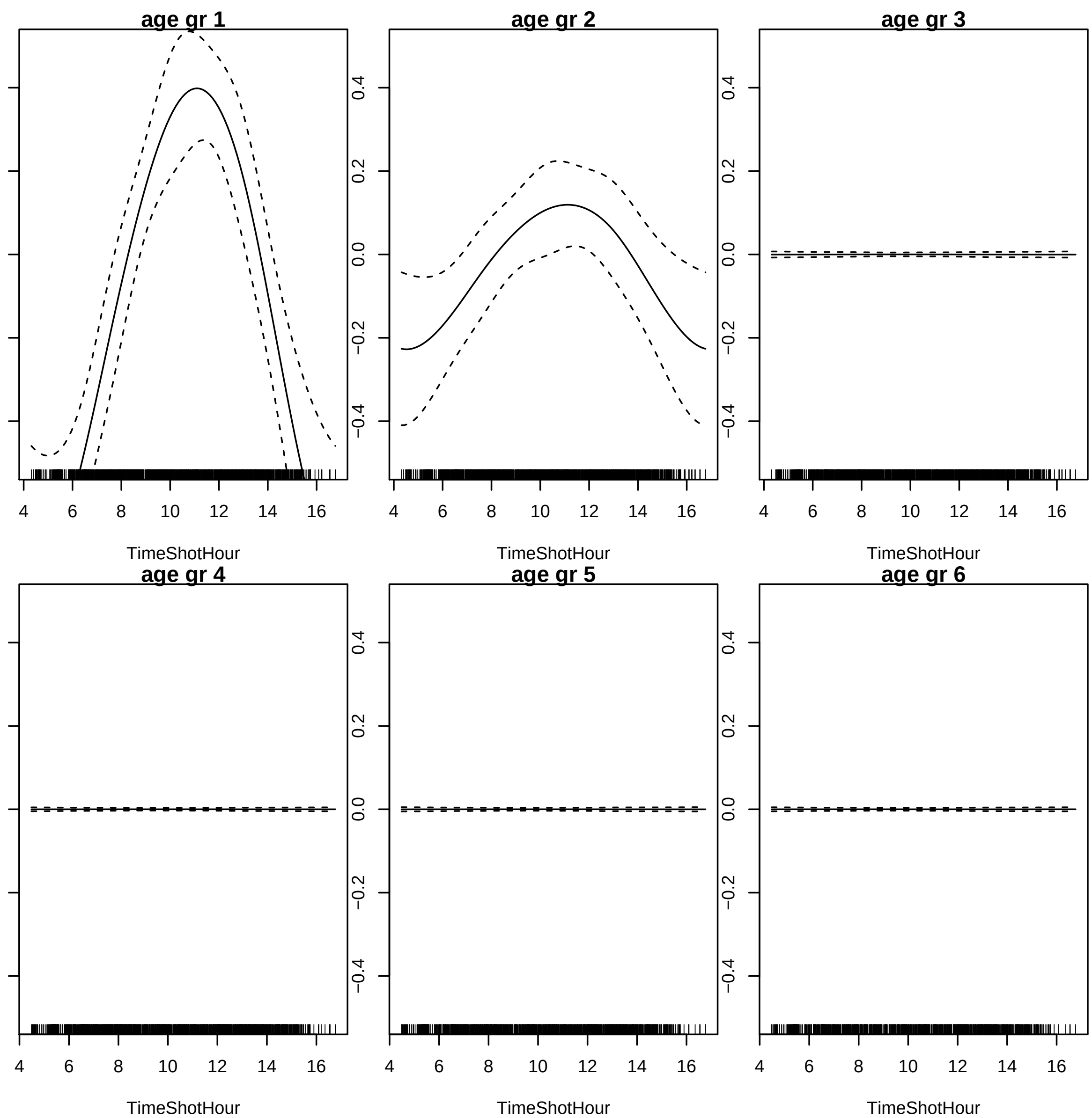

Figure 13: Estimated time of day effects Q3+Q4

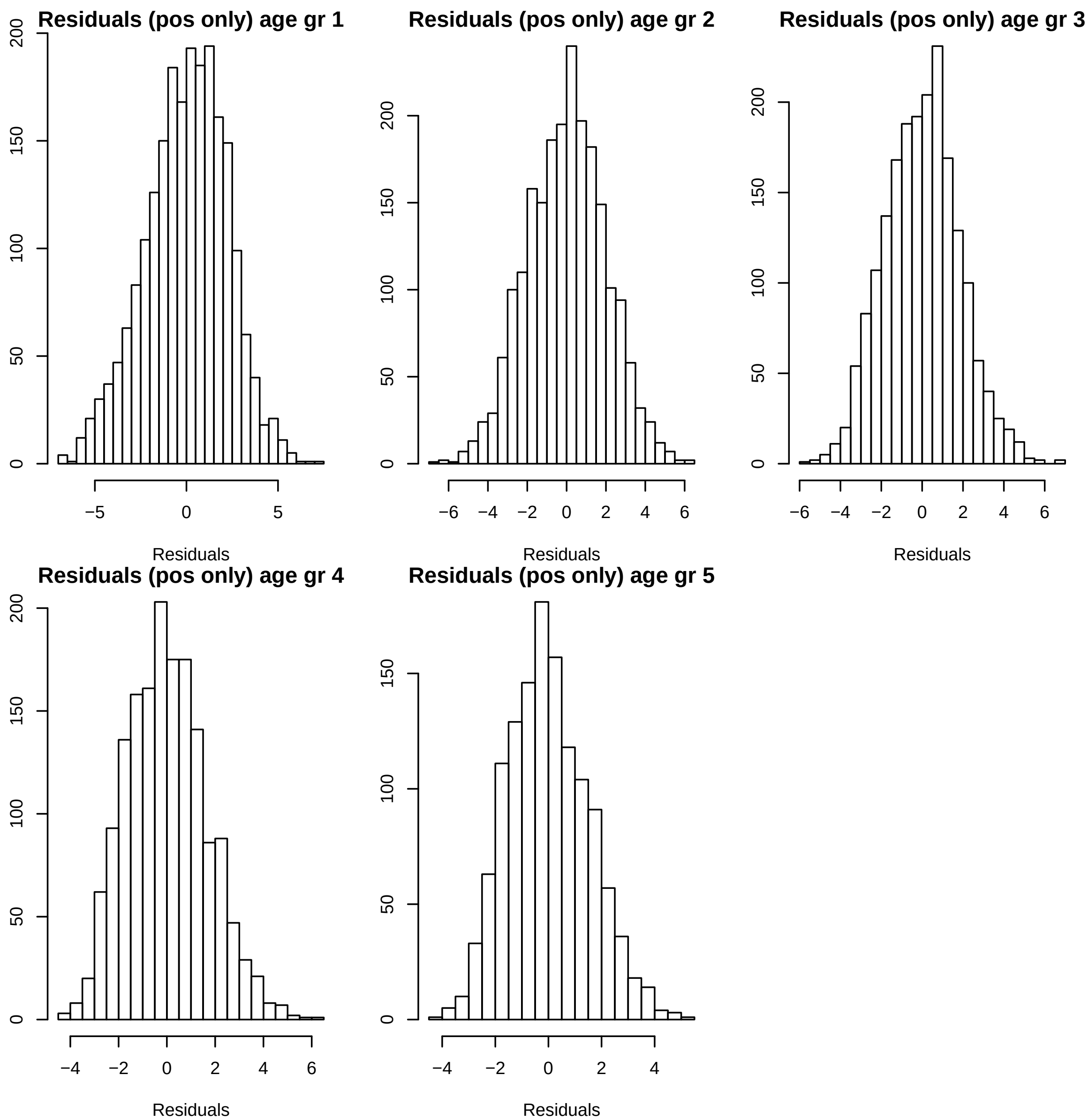

Figure 14: residuals Q1

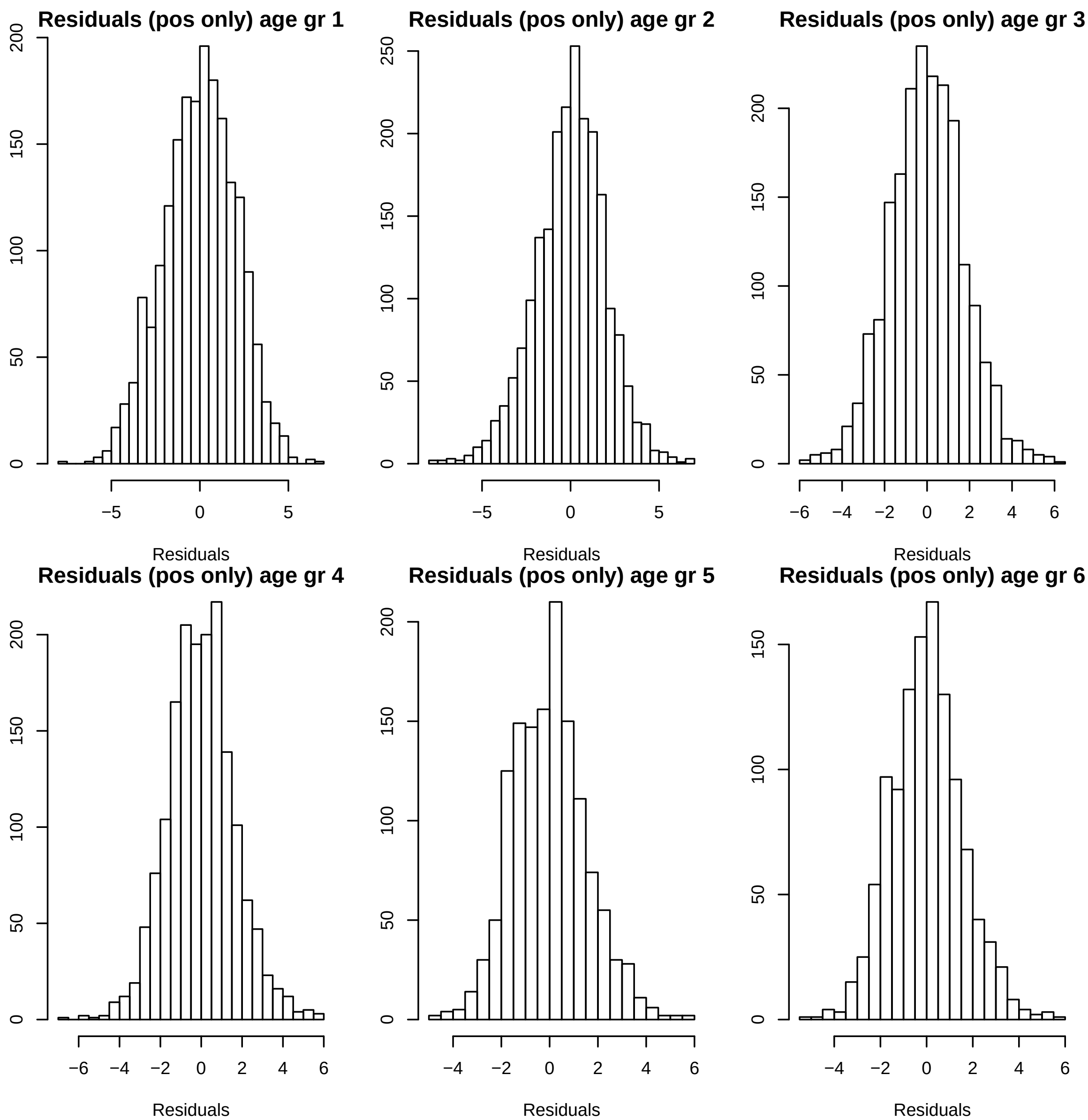

Figure 15: residuals Q3+Q4

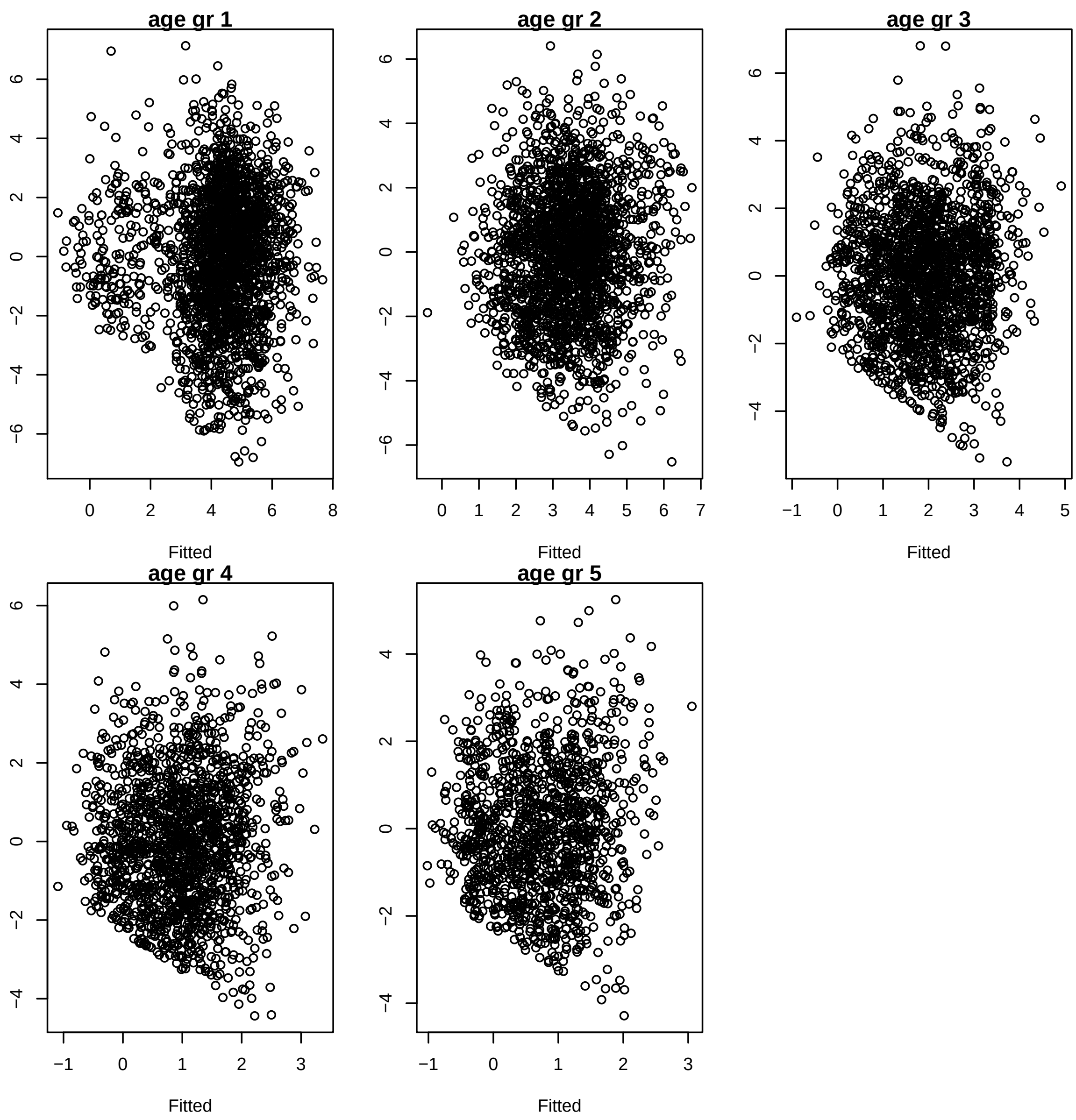

Figure 16: fitted versus residuals Q1

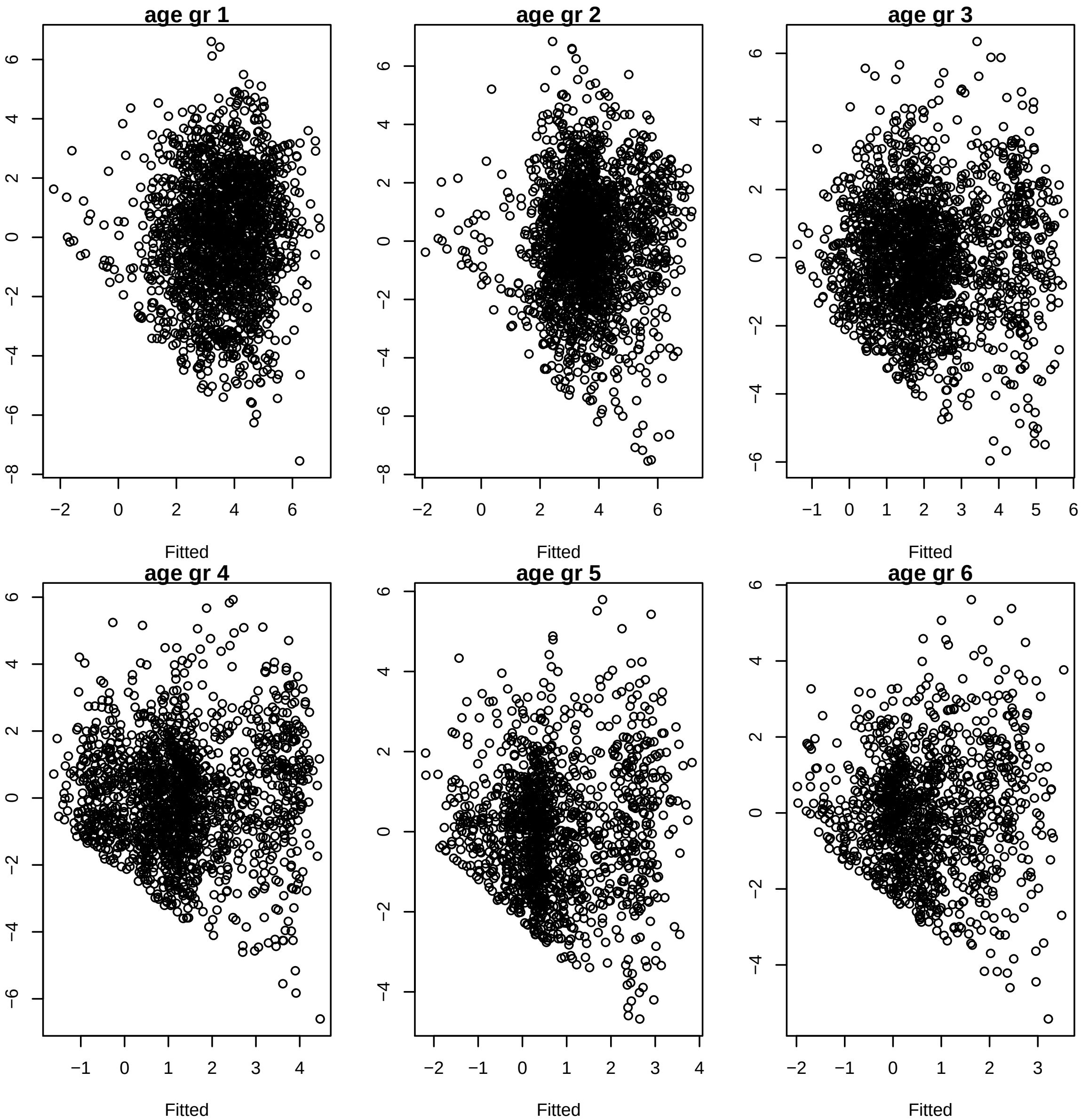

Figure 17: fitted versus residuals Q3+Q4

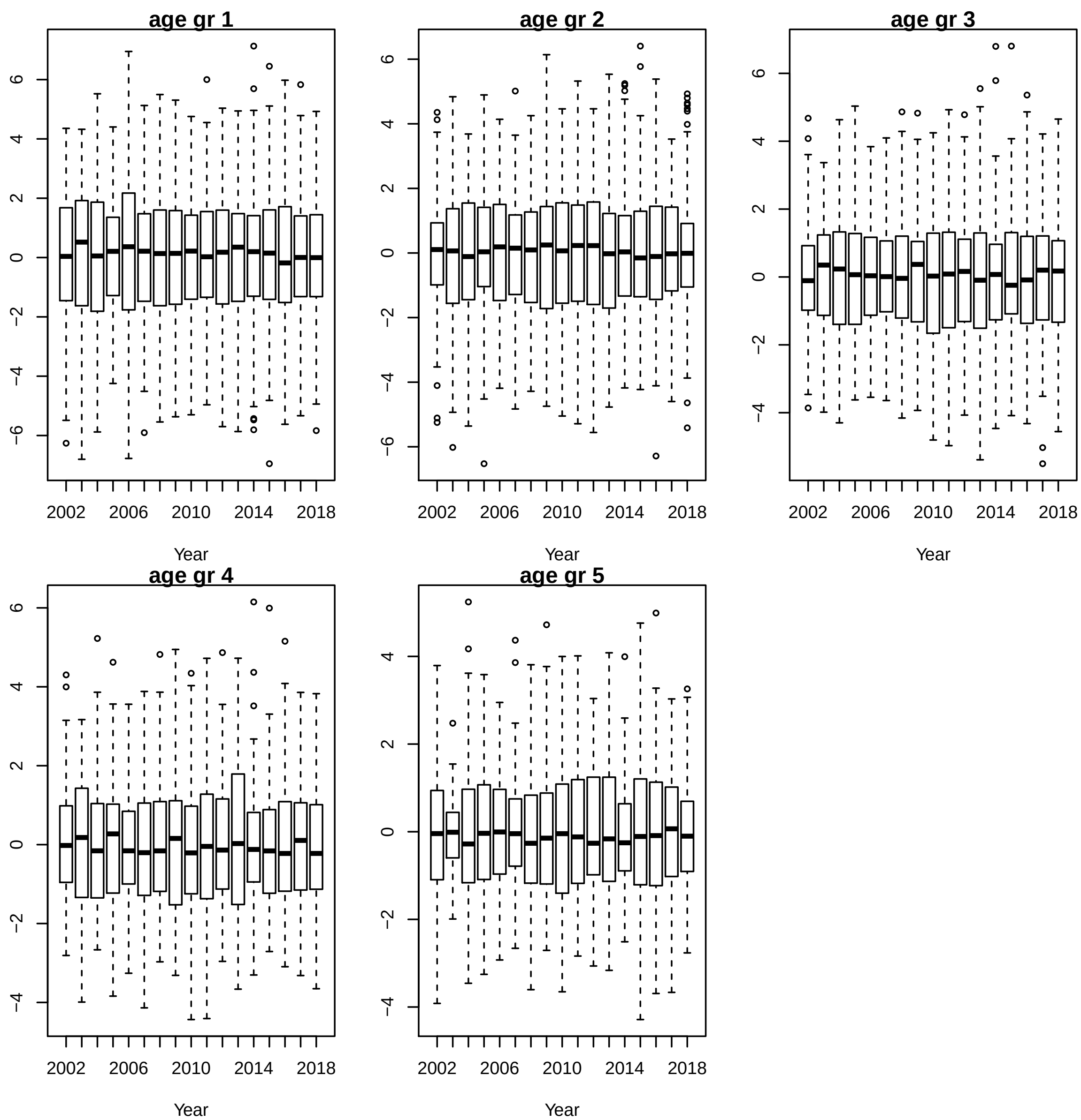

Figure 18: residuals by year Q1

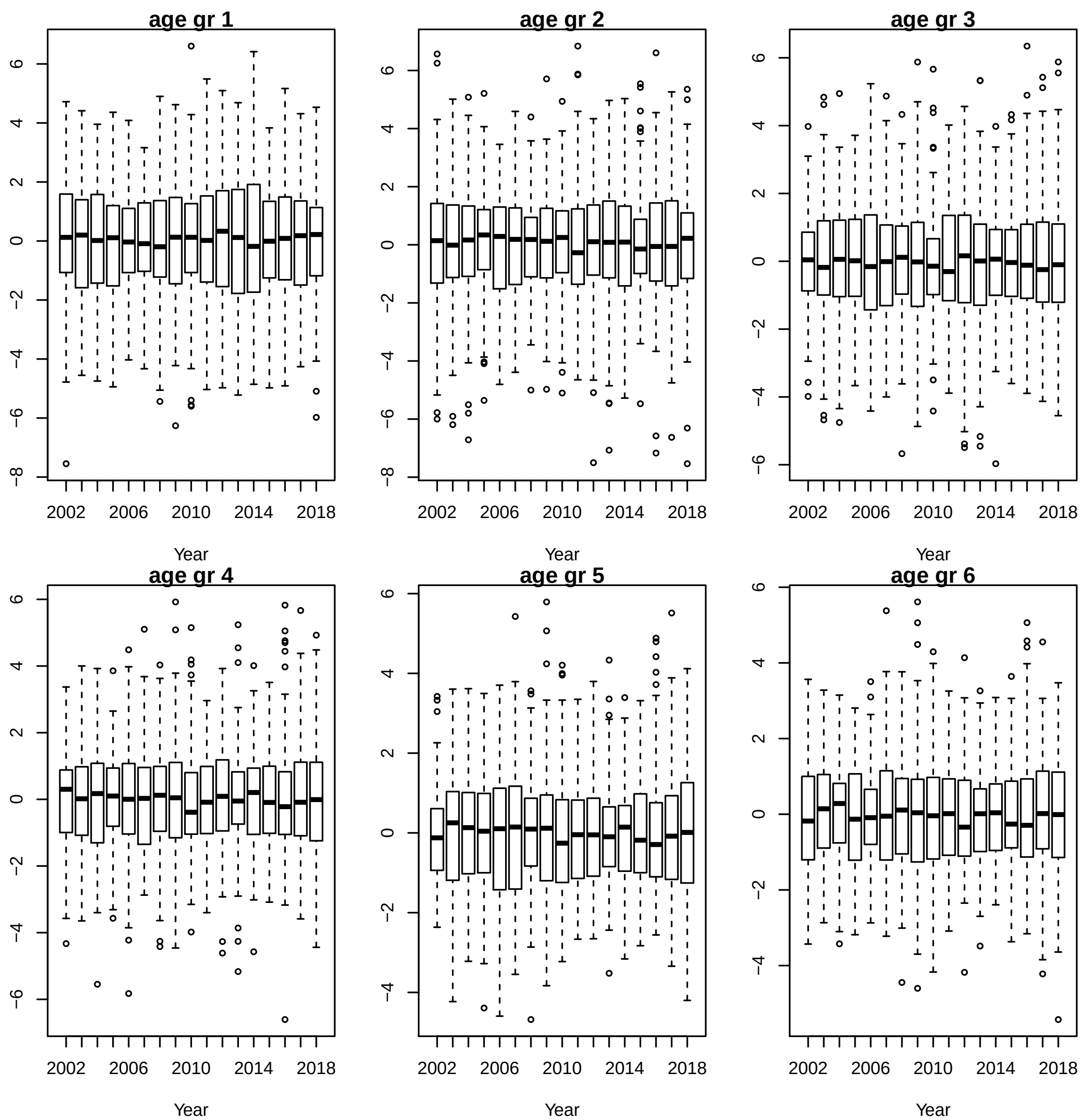

Figure 19: residuals by year Q3+Q4

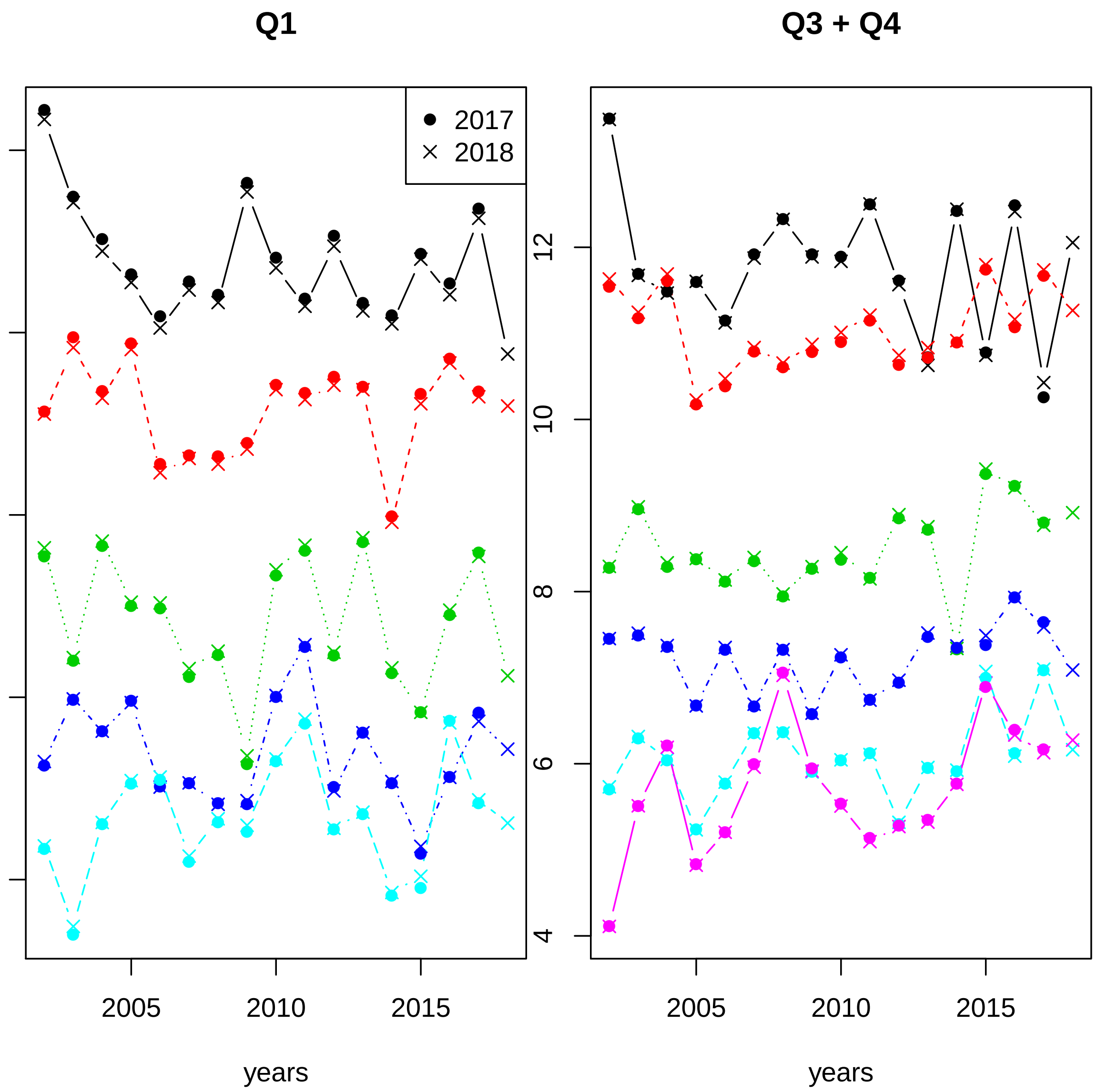

Figure 20: Comparison with last year's indices

WD 02

2018 Western Baltic spring spawning herring recruitment monitored by the Rügen Herring Larvae Survey

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Thünen Institute of Baltic Sea Fisheries (TI-OF), Germany

The waters of Greifswald Bay (ICES area 24) are considered a major spawning area of Western Baltic spring spawning (WBSS) herring. The German Thünen Institute of Baltic Sea Fisheries (TI-OF), Rostock, and its predecessor monitors the density of herring larvae as a vector of recruitment success since 1977 within the framework of the Rügen Herring Larvae Survey (RHLS). It delivers a unique high-resolution dataset on the herring larvae ecology in the Western Baltic, both temporally and spatially. Onboard the research vessel "FFS Clupea" a sampling grid including 35 stations is sampled weekly using ichthyoplankton gear (Bongo-net, mesh sizes 335 µm; 780 µm) during the main reproduction period from March to June. The weekly assessment of the entire sampling area is conducted within two days (detailed description of the survey design can be found in Polte 2013 (WD in ICES CM 2013/ACOM: 4). The collected data provide an important baseline for detailed investigations of spawning and recruitment ecology of WBSS herring spawning components. As a fishery-independent indicator of stock development, the recruitment index is incorporated into the assessment of the ICES Herring Assessment Working Group.
The rationale for the *N20* recruitment index is based on regular and strong correlations between the amount of larvae reaching a length of 20 mm (TL) in Greifswald Bay and abundance data of juveniles (1wr and 2wr fish) as determined by acoustic surveys in the Arkona and Belt Seas (GERAS).
Those recurring correlations (N20/GERAS, 1-wr; 1992-2018 R^2=0.74) support the underlying hypotheses that i) major variability of natural mortality occurs at early life stages before larvae reach a total length of 20 mm and ii) larval herring production in Greifswald Bay is an adequate proxy for annual recruitment strength of the WBSS herring stock.
The *N20* recruitment index is calculated every year based on data obtained from the RHLS. This is done by estimating weekly growth of larvae for seasonal temperature change and taking the sum of larvae reaching 20 mm by every survey week until the end of the investigation period. On the spatial scale, the 35 sampling stations are assigned to 5 strata and mean values of stations for each stratum are extrapolated to the strata area (for details see Oeberst et. al 2009). The sum of *N20* larvae caught over the investigation period in the entire area results in the *N20* recruitment index for those herring that enter the fishery as adults two to three years later.
Calculation procedures have been reviewed and re-established in 2007 and the recalculated index for the time series from 1992 onwards is used by HAWG since 2008 as 0-group recruitment index for the assessment of Western Baltic Spring Spawning herring.

2018 N20 index results:

With an estimated product of **1563 million** larvae, the 2018 *N20* recruitment index is in similar dimensions as the previous year and more than double as high as the record low of 2016 (Table 1, Figure 1). However, the value is only in the range of about 1/5 of the time series mean thus not countering the decreasing trend of larval production observed in the system during the past two decades.

The spawning process in spring 2018 took place under a quite special winter regime. The course of winter-water temperatures remained quite mild (Figure 2) until mid- February. When the first cruise (RHLS-winter control) started on February 2nd, the first spawning fishes were observed in own gill net samples in Greifswald Bay. About a week later a severe cold period started and water temperatures quickly dropped to 2 -0 °C. This temperature is considered below the critical temperature for vital embryonic development (Peck et al. 2012). Since herring in full spawning condition remained in the aggregation area in Pommeranian Bay for the entire period Greifswald Bay was ice covered, many individuals with abnormal ovaries were found in scientific as well as commercial samples. When the spawning process in Greifswald Bay continued in March, steep spring temperatures lead to rapid warming of the water and spawning ended early in the end of April (instead early May as usual). All these observations point on severe consequences of current phenology shifts on larval production and-survival. The trawl net fishery on pre-spawner aggregations in the Pommeranian Bay started on January 2nd. The gill net fishery on ripe fish on the spawning ground started on February 18th but then stopped due to the cold period (ice cover) and took up fishery again on Mar 12th. This fishery ended on Apr. 23rd.

Due to extended ice cover the regular Rügen-herring larvae Survey started late on March 23nd (10 days later than 2017) and was conducted until June 26th, over a 15 weeks period. Additionally on two dates in February (start Feb. 2nd) and November (start Nov 5th) control surveys were conducted testing for winter and autumn larvae respectively. During both controls a limited number of post-flexion larvae were observed in the system.

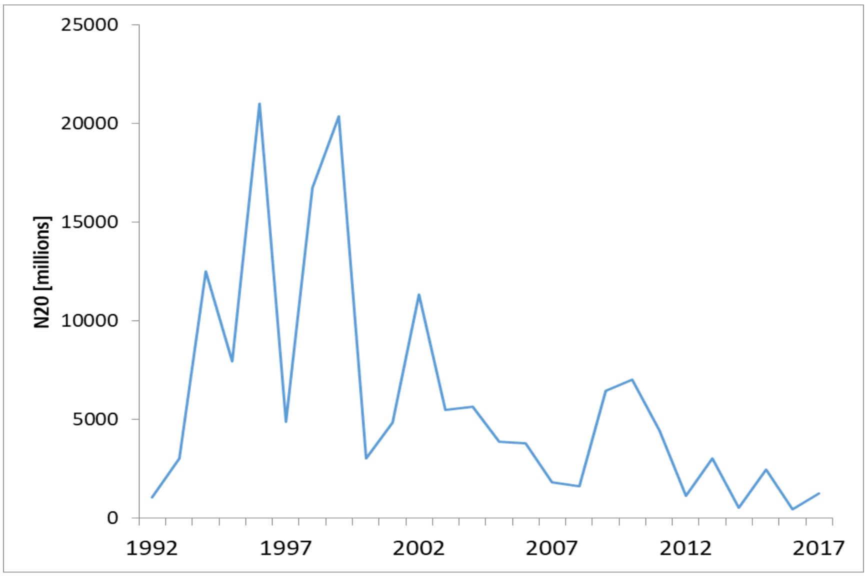

Figure 1 Validated RHLS time series with N20 index data presented as annual sum of 20 mm larvae in millions.

Table 1 *N20* larval herring index for spring spawning herring of the Western Baltic Sea (WBSS), generated by RHLS data.

Year	N20 (Millions)
1992	1060
1993	3044
1994	12515
1995	7930
1996	21012
1997	4872
1998	16743
1999	20364
2000	3026
2001	4845
2002	11324
2003	5507
2004	5640
2005	3887
2006	3774
2007	1829
2008	1622
2009	6464
2010	7037
2011	4444
2012	1140
2013	3021
2014	539
2015	2478
2016	442
2017	1247
2018	**1563**

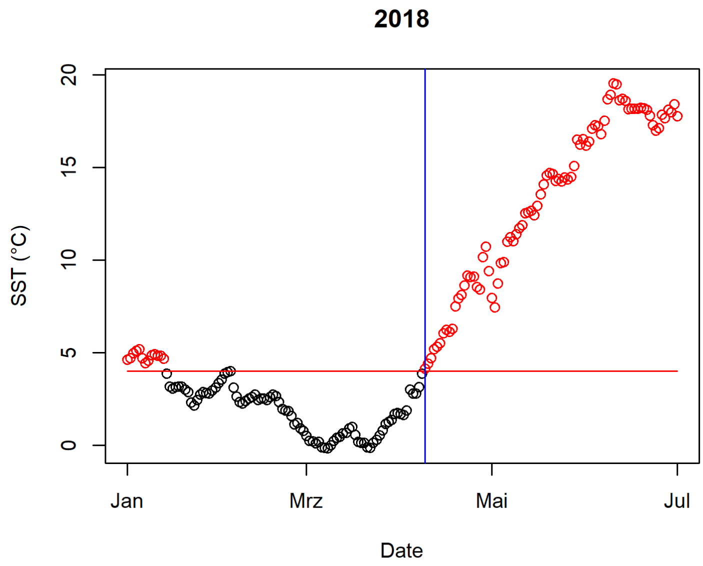

Figure 2 Daily mean sea surface temperature (SST) slope (*NASA Earth Observation project (http://neo.sci.gsfc.nasa.gov/*) in central Greifswald Bay 2018. Red line indicates a 4°C threshold for initial spawning activity. On both positions where SST reached this line, spawning activity was observed. The blue line indicates the beginning of the spring temperature curve covering egg development, larval hatch and larval growth/survival.

Revision of the relation between N20 and GERAS 1-wr herring after years with low larvae production

After the record low N20 in 2016 the relation with the 1-group juveniles as monitored by the German hydroacoustic survey (GERAS) after the one-year growth phase was re-evaluated to see if the recent years with extremely low larvae production results affect the former correlation with 1-wr juveniles on the scale of the western Baltic Sea. The results indicate no influence on the correlation between N20 and GERAS 1-wr juveniles. The low N20 years resulted in correspondingly low GERAS indices for the 1-wr juveniles (Fig. 3).

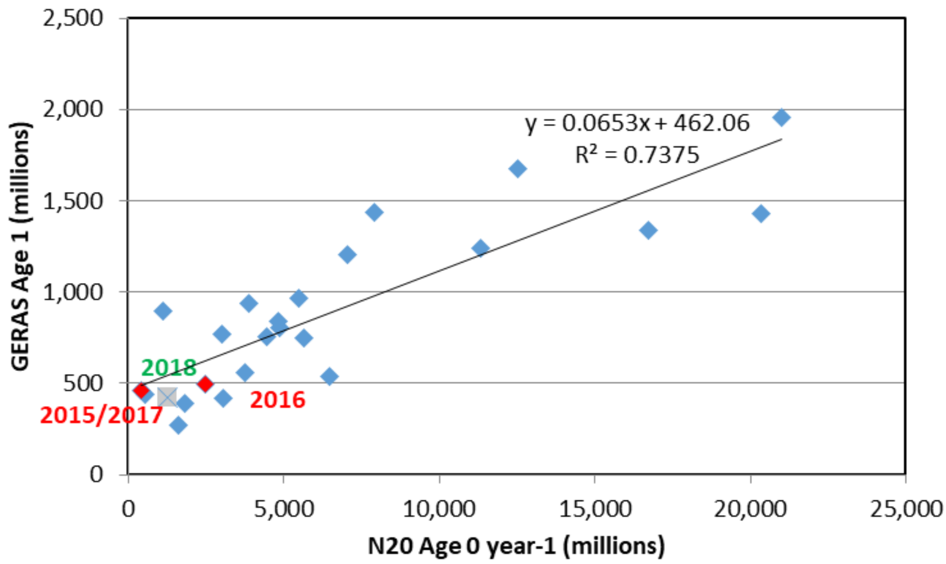

Figure 3 Correlation of N20 larvae index (1992-2017) with the 1-wr herring from GERAS (1993-2018). Note: The one-year lag phase between indices. E.g. the exceptionally low N20 year 2016 is represented by the GERAS 1-wr index 2017.

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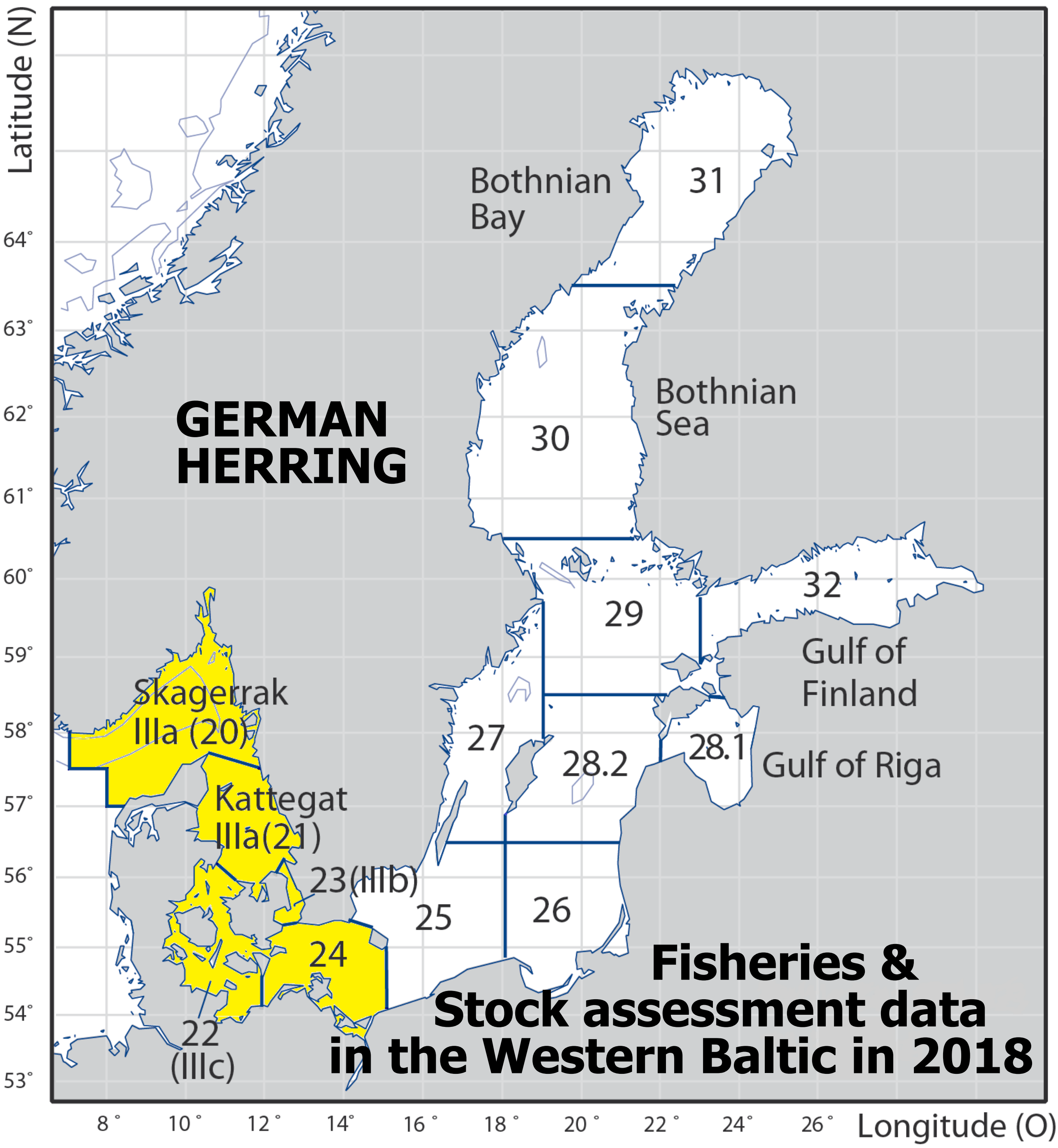

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SECTION **PAGE**

1 German herring fisheries in 2018

1.1 Fisheries

In 2018 the total German herring landings from the Western Baltic Sea in Subdivisions (SD) 22 and 24 amounted to 11,304, which represents a decrease of 23 % compared to the landings in 2017 (14,694 t). This decrease was caused by a decrease of the TAC/quota (German quota for SDs 22 and 24 in 2018: 9,551 t + quota-transfer of 2,434 t). The German quota in 2018 was only used by 94 % (2017: 88 %, 2016: 98). The fishing activities in one of the main fishing areas, the Greifswald Bay (SD 24), which started already in mid-February, had to be suspended at the end of February until mid-March due due to a cold period with ice coverage. The main German fishery stopped their activities at the end of April.

As in previous years some herring was also caught in the Skagerrak/Kattegat area (Division IIIa):

Year	Landings (t)
2005	751
2006	556
2007	454
2008	352 + 1,214 misreported from area SD 23
2009	887
2010	146
2011	54
2012	629
2013	195 (= 46 % of GER quota (>32 mm) of 421 t
2014	84 (= 27 % of GER quota (>32 mm) of 310 t
2015	128 (= 44 % of GER quota (>32 mm) of 289 t
2016	125 (= 37 % of GER quota (>32 mm) of 339 t
2017	85 (= 25 % of GER quota (> 32 mm) of 339 t*
2018	.206 (= 43 % of GER quota (>32 mm) of 358 t*

*Including a quota transfer of 1 t in 2017 and 34 t in 2018.

The landings (t by quarter and Sub-Division including information about the fraction of landings in foreign ports (**given as minus values**)) are shown in the table below:

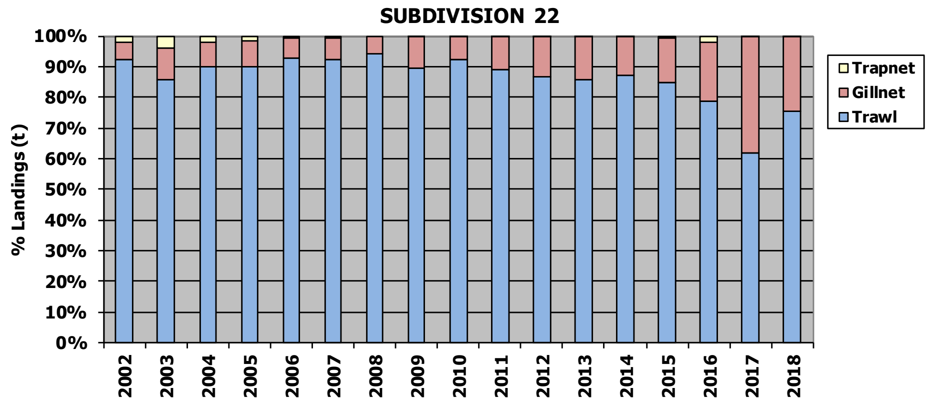
Quarter	Skag./Katteg. (t)	Subdiv. 22 (t)	Subdiv. 24 (t)	TOTAL (t)	TOTAL (%)
I		114.932	7,521.311	**7,636.243**	**66.3**
			-0.950	**-0.950**	**0.0**
II		13.538	2,471.531	**2,485.069**	**21.6**
			-1.500	**-1.500**	**0.0**
III	104.347	0.477	0.145	**104.969**	**0.9**
	-104.347			**-104.347**	**-0.9**
IV	101.534	7.375	1,174.924	**1,283.833**	**11.2**
			-0.440	**-0.440**	**0.0**
TOTAL	**205.881**	**136.322**	**11,167.911**	**11,510.114**	**100.0**
	-104.347	**0.000**	**-2.890**	**-107.237**	**-0.9**

Source: Federal Centre for Agriculture and Food (BLE). Since 2008 the obligation to report via logbooks changed to vessels >8 m (until 2007 for vessels >10 m)

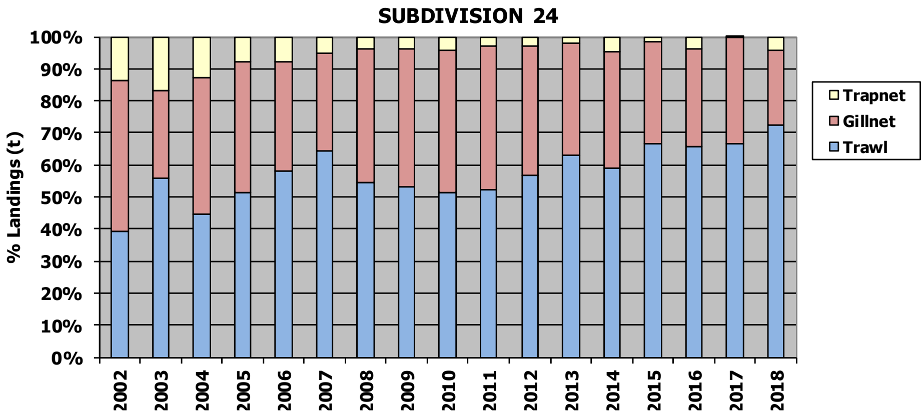
Landings = Total landings
-Landings = Fraction landed abroad

Just as in former years the main fishing season was during the first and second quarter. About 88 % of the herring in 2018 was caught between January and April (2017: 86 %, 2016 : 84 %, 2015: 84 %). As in last years, the main fishing area was located in Subdivision 24 (2016-2018: 97 %; 2015: 96 %, 2014: 93 %). The overall fishing pattern during the last years was rather stable in the Baltic area of Subdivisions 22 and 24. Until 2000, the dominant part of herring was caught in the passive fishery by gillnets and trapnets around the Island of Rügen. Since 2001, the activities in the trawl fishery have increased. They reached the highest contribution in 2018 of 72 % (2017: 66 %, 2017: 66 %). The trawl fishery was mostly carried out in Subdivision 24 (2016-2018: 98 %, 2015: 96 %, 2014: 91 %; 2013: 94). The change in fishing pattern since 2001 was caused by the perspective of a new fish processing factory on the Island of Rügen, which finally started the production in autumn 2003. This factory intends to process 50,000 t fish annually. The figure below shows the share of the different gear types in the German herring fishery for the years 2002-2018 in Subdivisions 22 and 24.

SD 22 (t)	Trawl	Gillnet	Trapnet	Total	SD 22 (%)	Trawl	Gillnet	Trapnet
2002	3,871.716	253.710	78.838	4,204.264	2002	92.1%	6.0%	1.9%
2003	3,147.054	382.678	150.007	3,679.739	2003	85.5%	10.4%	4.1%
2004	2,282.844	196.963	55.674	2,535.481	2004	90.0%	7.8%	2.2%
2005	1,700.627	162.795	29.312	1,892.734	2005	89.9%	8.6%	1.5%
2006	2,977.731	215.366	14.372	3,207.469	2006	92.8%	6.7%	0.4%
2007	1,922.914	139.321	16.395	2,078.630	2007	92.5%	6.7%	0.8%
2008	2,086.175	124.471	0.000	2,210.646	2008	94.4%	5.6%	0.0%
2009	1,436.082	171.106	0.910	1,608.098	2009	89.3%	10.6%	0.1%
2010	1,565.826	125.609	3.381	1,694.816	2010	92.4%	7.4%	0.2%
2011	1,040.724	124.015	3.073	1,167.812	2011	89.1%	10.6%	0.3%
2012	729.236	109.950	3.315	842.501	2012	86.6%	13.1%	0.4%
2013	610.485	99.970	2.708	713.163	2013	85.6%	14.0%	0.4%
2014	572.074	80.422	2.660	655.156	2014	87.3%	12.3%	0.4%
2015	404.439	70.548	2.382	477.369	2015	84.7%	14.8%	0.5%
2016	193.125	48.061	4.593	245.779	2016	78.6%	19.6%	1.9%
2017	190.689	117.481	0.004	308.174	2017	61.9%	38.1%	0.0%
2018	103.078	32.903	0.341	136.322	2018	75.6%	24.1%	0.3%



SD 24 (t)	Trawl	Gillnet	Trapnet	Total	SD 24 (%)	Trawl	Gillnet	Trapnet
2002	7,155.192	8,529.682	2,480.824	18,165.698	2002	39.4%	47.0%	13.7%
2003	8,425.517	4,162.634	2,508.141	15,096.292	2003	55.8%	27.6%	16.6%
2004	6,912.896	6,599.784	1,960.868	15,473.548	2004	44.7%	42.7%	12.7%
2005	9,863.481	7,761.212	1,522.218	19,146.911	2005	51.5%	40.5%	8.0%
2006	11,393.038	6,744.164	1,525.095	19,662.297	2006	57.9%	34.3%	7.8%
2007	14,449.006	6,937.814	1,117.411	22,504.231	2007	64.2%	30.8%	5.0%
2008	11,196.706	8,636.140	789.005	20,621.851	2008	54.3%	41.9%	3.8%
2009	7,617.179	6,232.206	523.088	14,372.473	2009	53.0%	43.4%	3.6%
2010	5,415.716	4,679.209	448.801	10,543.726	2010	51.4%	44.4%	4.3%
2011	3,654.547	3,177.875	186.600	7,019.022	2011	52.1%	45.3%	2.7%
2012	5,865.995	4,142.744	318.993	10,327.732	2012	56.8%	40.1%	3.1%
2013	8,742.420	4,833.203	301.719	13,877.342	2013	63.0%	34.8%	2.2%
2014	5,656.314	3,482.558	447.064	9,585.936	2014	59.0%	36.3%	4.7%
2015	8,517.972	4,112.581	181.151	12,811.704	2015	66.5%	32.1%	1.4%
2016	9,301.364	4,314.489	564.965	14,180.818	2016	65.6%	30.4%	4.0%
2017	9,585.798	4,781.359	19.100	14,386.257	2017	66.6%	33.2%	0.1%
2018	8,082.664	2,630.414	454.833	11,167.911	2018	72.4%	23.6%	4.1%



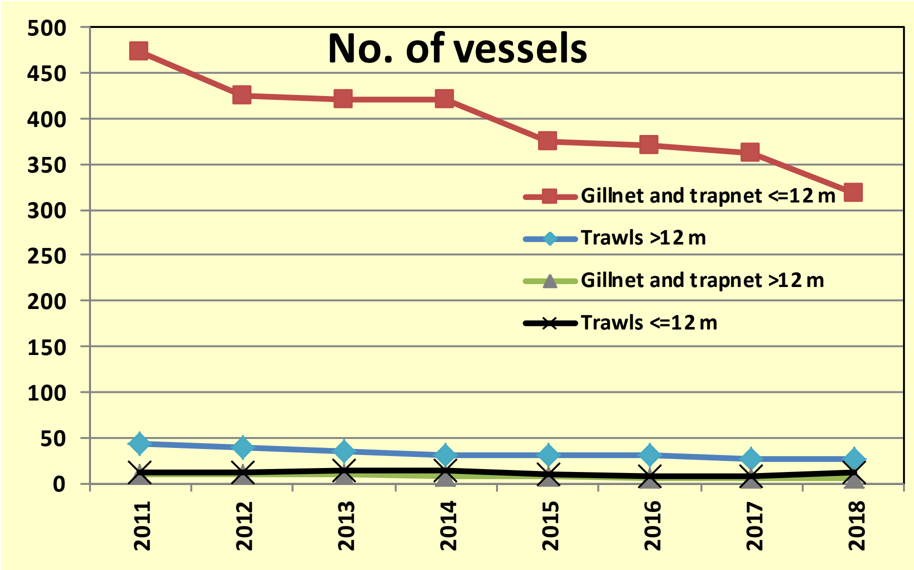
1.2 Fishing fleet

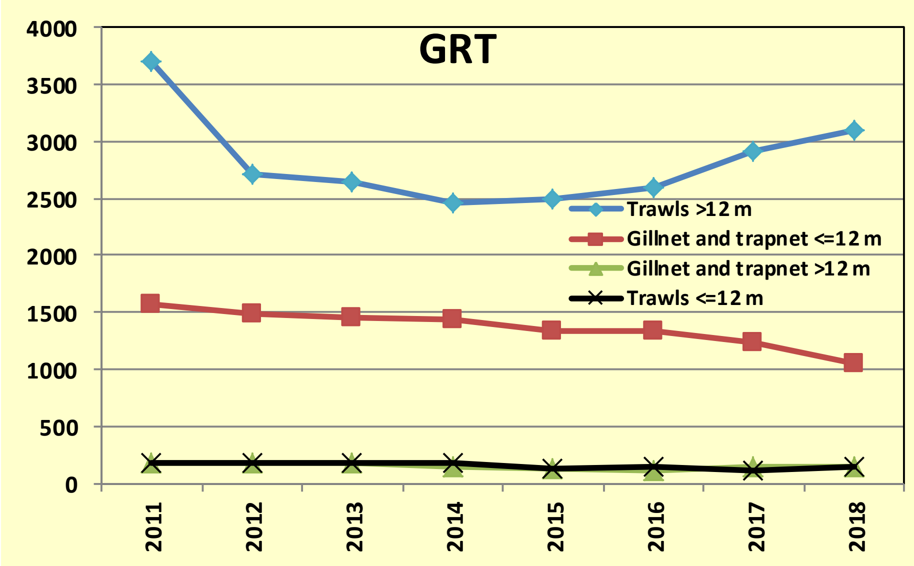
The German fishing fleet in the Baltic Sea consists of two parts where all catches for herring are taken in a directed fishery:

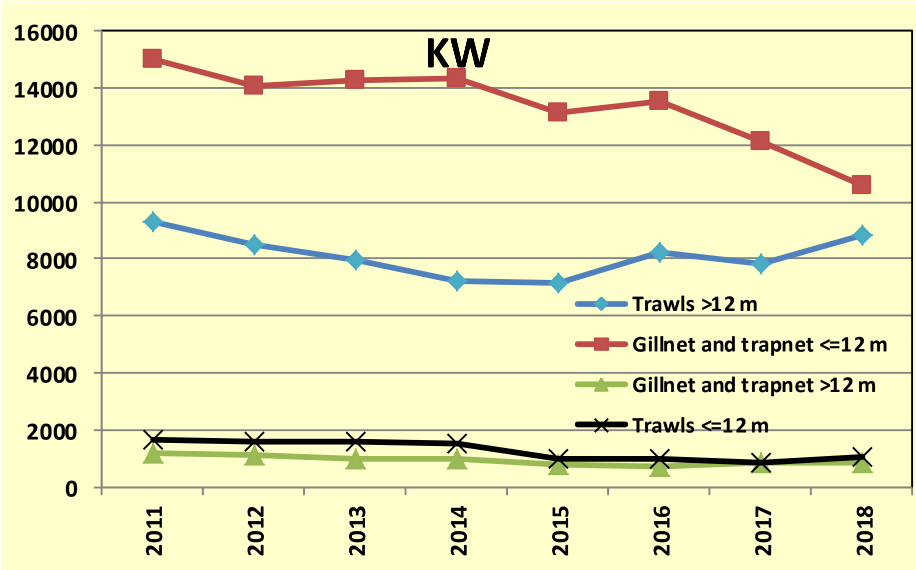
- coastal fleet with undecked vessels (rowing/motor boats <=10 m, engine power <=100 HP)
- cutter fleet with decked vessels and total lengths between 12 m and 30 m.

In the years from 2011 until 2018 the following types of fishing vessels carried out the herring fishery in the Baltic (only referring to vessels, which are contributing to the overall total landings per year with more than 20 %):

	Type of gear	Vessel length (m)	No. of vessels	GRT	kW
2011	Fixed gears (gillnet and trapnet)	<=12	473	1,566	15,020
		>12	10	185	1,215
	Trawls	<=12	12	171	1,666
		>12	43	3,710	9,325
	TOTAL		**538**	**5,632**	**27,226**
2012	Fixed gears (gillnet and trapnet)	<=12	426	1,485	14,105
		>12	9	184	1,125
	Trawls	<=12	12	170	1,573
		>12	38	2,712	8,480
	TOTAL		**485**	**4,551**	**25,283**
2013	Fixed gears (gillnet and trapnet)	<=12	421	1,459	14,289
		>12	9	186	1,005
	Trawls	<=12	14	173	1,557
		>12	35	2,638	7,960
	TOTAL		**479**	**4,456**	**24,811**
2014	Fixed gears (gillnet and trapnet)	<=12	421	1,443	14,351
		>12	8	149	970
	Trawls	<=12	13	170	1,502
		>12	31	2,469	7,205
	TOTAL		**473**	**4,231**	**24,028**
2015	Fixed gears (gillnet and trapnet)	<=12	375	1,341	13,163
		>12	7	133	802
	Trawls	<=12	9	122	991
		>12	31	2,503	7,148
	TOTAL		**422**	**4,099**	**22,104**
2016	Fixed gears (gillnet and trapnet)	<=12	371	1,341	13,532
		>12	5	103	699
	Trawls	<=12	8	137	997
		>12	30	2,599	8,205
	TOTAL		**414**	**4,180**	**23,433**
2017	Fixed gears (gillnet and trapnet)	<=12	362	1,237	12,158
		>12	6	148	874
	Trawls	<=12	8	113	872
		>12	27	2,910	7,816
	TOTAL		**403**	**2,910**	**21,720**
2018	Fixed gears (gillnet and trapnet)	<=12	319	1,049	10,572
		>12	6	148	874
	Trawls	<=12	11	143	1,080
		>12	26	3,093	8,815
	TOTAL		**362**	**4,433**	**21,341**


No. of vessels
Gillnet and trapnet <=12 m
Trawls >12 m
Gillnet and trapnet >12 m
Trawls <=12 m
500
450
400
350
300
250
200
150
100
50
0
2011
2012
2013
2014
2015
2016
2017
2018


GRT
Trawls >12 m
Gillnet and trapnet <=12 m
Gillnet and trapnet >12 m
Trawls <=12 m
4000
3500
3000
2500
2000
1500
1000
500
0
2011
2012
2013
2014
2015
2016
2017
2018


KW
Trawls >12 m
Gillnet and trapnet <=12 m
Gillnet and trapnet >12 m
Trawls <=12 m
16000
14000
12000
10000
8000
6000
4000
2000
0
2011
2012
2013
2014
2015
2016
2017
2018

1.3 Species composition of landings

The catch composition from gillnet and trapnet consists of nearly 100 % of herring.

The results from the species composition of German trawl catches, which were sampled in **Subdivision 24** of quarter 1 and 4 in 2018, are given below:

SD 24/Quarter I		Weight (kg)					Weight (%)			
	Sample No.	Herring	Sprat	Cod	Other	Total	Herring	Sprat	Cod	Other
January	1	57.4	0.0	0.0	0.0	57.4	100.0	0.0	0.0	0.0
	2	61.5	0.0	0.0	0.0	61.5	100.0	0.0	0.0	0.0
	3	53.6	0.0	0.0	0.0	53.6	100.0	0.0	0.0	0.0
	Mean	57.5	0.0	0.0	0.0	57.5	100.0	0.0	0.0	0.0
February	1	69.7	0.0	0.0	0.0	69.7	100.0	0.0	0.0	0.0
	2									
	3									
	Mean	69.7	0.0	0.0	0.0	69.7	100.0	0.0	0.0	0.0
March	1	43.7	0.0	0.0	0.0	43.8	100.0	0.0	0.0	0.0
	2	50.2	0.0	0.0	0.0	50.2	100.0	0.0	0.0	0.0
	3	56.9	0.1	0.0	0.0	56.9	99.9	0.1	0.0	0.0
	Mean	50.3	0.0	0.0	0.0	50.3	100.0	0.0	0.0	0.0
Q I	Mean	59.2	0.0	0.0	0.0	59.2	100.0	0.0	0.0	0.0

SD 24/Quarter IV		Weight (kg)					Weight (%)			
	Sample No.	Herring	Sprat	Cod	Other	Total	Herring	Sprat	Cod	Other
Octob.	1									
	2									
	3									
	Mean									
Novemb.	1									
	2									
	3									
	Mean									
Decemb.	1	60.580	0.419	0.000	0.000	60.999	99.3	0.7	0.0	0.0
	2									
	3									
	Mean	60.580	0.419	0.000	0.000	60.999	99.3	0.7	0.0	0.0
Q IV	Mean	60.580	0.419	0.000	0.000	60.999	99.3	0.7	0.0	0.0

The officially reported total trawl landings of herring in Subdivison 24 (see 2.1) in combination with the detected mean species composition in the samples (see above) results in the following differences:

Subdiv.	Quarter	Trawl landings (t)	Mean Contribution of Herring (%)	Total Herring corrected (t)	Difference (t)
24	I	**6,740**	100.0	6,740	0
	IV	**1,122**	99.3	1,115	-8

The officially reported trawl landings in Subdivision 24 (see 2.1) and the referring assessment input data (see 2.2 and 2.3) were as in last years not corrected since the results would only result in overall small changes of the official statistics (total trawl landings in Subdivision 22 and 24 of 8186 t – 8 t -> 0.1 % difference).

1.4 Logbook registered discards/BMS landings

No BMS landings (both new catch categories since 2015) of herring have been reported in the German herring fisheries in 2018 (no BMS landing have been reported since 2015). A total amount logbook registered discards of 14.507 t (quarter 1: 3.133 t; quarter 2: 11.374) were recorded by the German fisherman (as predation by seals?) in the gillnet fisheries in SD 24 in 2018. Neither discards nor logbook registered discards have been reported before 2018.

1.5 Central Baltic herring

In the western Baltic, the distribution areas of two stocks, the Western Baltic Spring Spawning herring (WBSSH) and the Central Baltic herring (CBH) overlap. German autumn acoustic survey (GERAS) results indicated in the recent years that in SD 24, which is part of the WBSSH management area, a considerable fraction of CBH is present and correspondingly erroneously allocated to WBSSH stock indices (ICES, 2013). Accordingly, a stock separation function (SF) based on growth parameters in 2005 to 2010 has been developed to quantify the proportion of CBH and WBSSH in the area (Gröhsler et al., 2013, Gröhsler et al., 2016). The estimates of the growth parameters based on baseline samples of WBSSH and CBH support the applicability of SF in 2011-2018 (Oeberst et al., 2013, WD Oeberst et al., 2014, WD Oeberst et al., 2015; WD Oeberst et al., 2016; WD Oeberst et al., 2017; WD Gröhsler, T. and Schaber, M., 2018, WD Gröhsler, T. and Schaber, M., 2019). SF (slightly modified by commercial samples) was employed in the years 2005-2016 to identify the fraction of Central Baltic Herring in German commercial herring landings from SD 22 and 24 (WD Gröhsler et al., 2013; ICES, 2018). Results showed a rather low share of CBH in landings from all métiers but indicated that the actual degree of mixing might be underrepresented in commercial landings as German commercial fisheries target pre-spawning and spawning aggregations of WBSSH.

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2 Stock assessment data in 2018

2.1 Landings (tons) and sampling effort

Gear	Quarter	SKAGERRAK (DIVISION IIIaN/SD 20) Landings (tons)	No. samples	No. measured	No. aged	KATTEGAT (DIVISION IIIaS/SD21) Landings (tons)	No. samples	No. measured	No. aged
TRAWL	Q 1	no landings	-	-	-	no landings	-	-	-
	Q 2	no landings	-	-	-	no landings	-	-	-
	Q 3	104.347	0	0	0	no landings	-	-	-
	Q 4	101.534	0	0	0	no landings	-	-	-
	Total	205.881	0	0	0	0.000	0	0	0
GILLNET	Q 1	no landings	-	-	-	no landings	-	-	-
	Q 2	no landings	-	-	-	no landings	-	-	-
	Q 3	no landings	-	-	-	no landings	-	-	-
	Q 4	no landings	-	-	-	no landings	-	-	-
	Total	0.000	0	0	0	0.000	0	0	0
TRAPNET	Q 1	no landings	-	-	-	no landings	-	-	-
	Q 2	no landings	-	-	-	no landings	-	-	-
	Q 3	no landings	-	-	-	no landings	-	-	-
	Q 4	no landings	-	-	-	no landings	-	-	-
	Total	0.000	0	0	0	0.000	0	0	0
TOTAL	Q 1	**0.000**	**0**	**0**	**0**	**0.000**	**0**	**0**	**0**
	Q 2	**0.000**	**0**	**0**	**0**	**0.000**	**0**	**0**	**0**
	Q 3	**104.347**	**0**	**0**	**0**	**0.000**	**0**	**0**	**0**
	Q 4	**101.534**	**0**	**0**	**0**	**0.000**	**0**	**0**	**0**
	Total	**205.881**	**0**	**0**	**0**	**0.000**	**0**	**0**	**0**

Gear	Quarter	SUBDIVISION 22 Landings (tons)	No. samples	No. measured	No. aged	SUBDIVISION 24 Landings (tons)	No. samples	No. measured	No. aged
TRAWL	Q 1	102.877	0	0	0	6,739.938	7	2,924	726
	Q 2	0.201	0	0	0	220.305	0	0	0
	Q 3	0.000	-	-	-	0.000	-	-	-
	Q 4	0.000	-	-	-	1,122.421	1	349	119
	Total	103.078	0	0	0	8,082.664	8	3,273	845
GILLNET	Q 1	11.953	1	339	70	757.373	6	2,124	343
	Q 2	13.324	3	1,217	169	1,820.398	6	2,324	350
	Q 3	0.464	0	0	0	0.145	0	0	0
	Q 4	7.162	0	0	0	52.498	0	0	0
	Total	32.903	4	1,556	239	2,630.414	12	4,448	693
TRAPNET	Q 1	0.102	0	0	0	24.000	0	0	0
	Q 2	0.013	1	321	49	430.828	2	798	198
	Q 3	0.013	0	0	0	0.000	-	-	-
	Q 4	0.213	0	0	0	0.005	0	0	0
	Total	0.341	1	321	49	454.833	2	798	198
TOTAL	Q 1	**114.932**	**1**	**339**	**70**	**7,521.311**	**13**	**5,048**	**1,069**
	Q 2	**13.538**	**4**	**1,538**	**218**	**2,471.531**	**8**	**3,122**	**548**
	Q 3	**0.477**	**0**	**0**	**0**	**0.145**	**0**	**0**	**0**
	Q 4	**7.375**	**0**	**0**	**0**	**1,174.924**	**1**	**349**	**119**
	Total	**136.322**	**5**	**1,877**	**288**	**11,167.911**	**22**	**8,519**	**1,736**

Gear	Quarter	TOTAL (DIV. IIIa & SUBDIV. 22+24)			
		Landings (tons)	No. samples	No. measured	No. aged
TRAWL	Q 1	6,842.815	7	2,924	726
	Q 2	220.506	0	0	0
	Q 3	104.347	0	0	0
	Q 4	1,223.955	1	349	119
	Total	8,391.623	8	3,273	845
GILLNET	Q 1	769.326	7	2,463	413
	Q 2	1,833.722	9	3,541	519
	Q 3	0.609	0	0	0
	Q 4	59.660	0	0	0
	Total	2,663.317	16	6,004	932
TRAPNET	Q 1	24.102	0	0	0
	Q 2	430.841	3	1,119	247
	Q 3	0.013	0	0	0
	Q 4	0.218	0	0	0
	Total	455.174	3	1,119	247
TOTAL	Q 1	7,636.243	14	5,387	1,139
	Q 2	2,485.069	12	4,660	766
	Q 3	104.969	0	0	0
	Q 4	1,283.833	1	349	119
	Total	11,510.114	27	10,396	2,024

2.2 Catch in numbers (millions)

		SUBDIVISION 20				SUBDIVISION 22				SUBDIVISION 24				SUBDIVISIONS 22+24			
	W-rings	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
TRAWL	0												0.126				0.126
	1					0.001	0.0000			0.069	0.002		0.272	0.070	0.002		0.272
	2					0.005	0.0000			0.302	0.010		1.928	0.307	0.010		1.928
	3					0.155	0.0003			10.133	0.331		2.465	10.288	0.332		2.465
	4					0.106	0.0002			6.934	0.227		0.613	7.040	0.227		0.613
	5					0.328	0.0006			21.496	0.703		2.481	21.824	0.703		2.481
	6					0.095	0.0002			6.220	0.203		0.538	6.315	0.204		0.538
	7					0.049	0.0001			3.221	0.105		0.341	3.271	0.105		0.341
	8+					0.026	0.0000			1.673	0.055			1.698	0.055		
	Sum					0.764	0.0015			50.048	1.636		8.763	50.812	1.637		8.763
	W-rings	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
GILLNET	0																
	1																
	2																
	3					0.002	0.0005	0.0000	0.000		0.033	0.0000	0.001	0.002	0.033	0.000	0.001
	4					0.006	0.002	0.0001	0.001	**0.148**	0.433	0.0000	0.012	0.154	0.435	0.000	0.014
	5					0.006	0.021	0.0007	0.011	**2.082**	5.272	0.0004	0.152	2.089	5.293	0.001	0.163
	6					0.008	0.030	0.0011	0.016	**0.928**	2.491	0.0002	0.072	0.937	2.522	0.001	0.088
	7					0.027	0.020	0.0007	0.011	**0.878**	1.955	0.0002	0.056	0.905	1.975	0.001	0.067
	8+					0.017	0.009	0.0003	0.005	**0.301**	0.973	0.0001	0.028	0.319	0.982	0.000	0.033
	Sum					0.067	0.083	0.0029	0.045	**4.338**	11.157	0.0009	0.322	4.405	11.240	0.004	0.367
	W-rings	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
TRAPNET	0																
	1					0.000	0.000	0.0000	0.0004					0.000	0.000	0.0000	0.0004
	2					0.001	0.0002	0.0002	0.0025	0.002	0.036		0.00000	0.003	0.036	0.0002	0.0025
	3					0.0003	0.0000	0.0000	0.0006	0.070	1.264		0.00001	0.071	1.264	0.0000	0.0006
	4					0.0001	0.0000	0.0000	0.0003	0.044	0.788		0.00001	0.044	0.788	0.0000	0.0003
	5									0.087	1.568		0.00002	0.087	1.568		0.0000
	6									0.016	0.289		0.00000	0.016	0.289		0.0000
	7									0.013	0.235		0.00000	0.013	0.235		0.0000
	8+									0.004	0.074		0.00000	0.004	0.074		0.0000
	Sum					0.0018	0.000	0.0002	0.0038	0.237	4.253		0.00005	0.239	4.253	0.0002	0.0039
	W-rings	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**	**Q1**	**Q2**	**Q3**	**Q4**
TOTAL	0												0.126				0.126
	1					0.001	0.000	0.000	0.0004	0.069	0.002		0.272	0.070	0.002	0.000	0.272
	2					0.0058	0.000	0.000	0.0025	0.304	0.046		1.928	0.310	0.046	0.000	1.931
	3					0.157	0.001	0.000	0.0009	10.204	1.628	0.000	2.466	10.361	1.628	0.000	2.467
	4					0.112	0.003	0.000	0.0016	7.126	1.447	0.000	0.625	7.238	1.450	0.000	0.627
	5					0.334	0.021	0.001	0.0112	23.665	7.543	0.000	2.633	24.000	7.564	0.001	2.644
	6					0.103	0.031	0.001	0.0164	7.165	2.984	0.000	0.609	7.268	3.014	0.001	0.626
	7					0.076	0.020	0.001	0.0107	4.112	2.295	0.000	0.398	4.189	2.315	0.001	0.408
	8+					0.043	0.009	0.000	0.0051	1.978	1.102	0.000	0.028	2.021	1.111	0.000	0.033
	Sum					0.833	0.085	0.003	0.0486	54.623	17.046	0.001	9.085	55.456	17.131	0.004	9.133

REPLACEMENT OF MISSING SAMPLES:

SUBDIVISION 22					SUBDIVISION 24				
Missing		Replacement by			Missing		Replacement by		
Gear	Quart.	Area	Gear	Quart.	Gear	Quart.	Area	Gear	Quart.
Trawl	1, 2	24	Trawl	1	Trawl	2	24	Trawl	1
Gillnet	3, 4	22	Gillnet	2	Gillnet	3, 4	24	Gillnet	2
Trapnet	1, 3, 4	22	Trapnet	2	Trapnet	1, 4	24	Trapnet	2

2.3 Mean weight (grammes) in the catch

		SUBDIVISION 20				SUBDIVISION 22				SUBDIVISION 24				SUBDIVISIONS 22+24			
	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TRAWL	0												17.9				17.9
	1					19.6	19.6			19.6	19.6		49.6	19.6	19.6		49.6
	2					49.1	49.1			49.1	49.1		79.7	49.1	49.1		79.7
	3					93.0	93.0			93.0	93.0		110.7	93.0	93.0		110.7
	4					112.7	112.7			112.7	112.7		142.9	112.7	112.7		142.9
	5					147.4	147.4			147.4	147.4		167.9	147.4	147.4		167.9
	6					157.3	157.3			157.3	157.3		196.2	157.3	157.3		196.2
	7					166.5	166.5			166.5	166.5		207.2	166.5	166.5		207.2
	8+					189.4	189.4			189.4	189.4			189.4	189.4		
	Sum					134.7	134.7			134.7	134.7		128.1	134.7	134.7		128.1
	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
GILLNET	0																
	1																
	2																
	3					153.5	101.9	101.9	101.9		111.1	111.1	111.1	153.5	111.0	103.1	109.0
	4					138.5	150.1	150.1	150.1	160.4	142.9	142.9	142.9	159.5	142.9	147.9	143.5
	5					149.5	149.6	149.6	149.6	167.6	158.7	158.7	158.7	167.6	158.6	153.0	158.1
	6					182.7	159.9	159.9	159.9	177.9	164.2	164.2	164.2	177.9	164.2	160.6	163.4
	7					185.1	165.4	165.4	165.4	182.7	168.4	168.4	168.4	182.8	168.3	166.0	167.9
	8+					190.0	176.3	176.3	176.3	196.0	185.0	185.0	185.0	195.7	185.0	178.0	183.7
	Sum					177.4	159.9	159.9	159.9	174.6	163.2	163.2	163.2	174.6	163.1	160.6	162.8
	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TRAPNET	0																
	1					45.5	45.5	45.5	45.5					45.5	45.5	45.5	45.5
	2					55.0	55.0	55.0	55.0	47.6	47.6		47.6	50.4	47.7	55.0	55.0
	3					62.5	62.5	62.5	62.5	74.9	74.9		74.9	74.9	74.9	62.5	62.8
	4					60.9	60.9	60.9	60.9	95.6	95.6		95.6	95.5	95.6	60.9	61.9
	5									117.8	117.8		117.8	117.8	117.8		117.8
	6									116.2	116.2		116.2	116.2	116.2		116.2
	7									128.4	128.4		128.4	128.4	128.4		128.4
	8+									145.4	145.4		145.4	145.4	145.4		145.4
	Sum					55.6	55.6	55.6	55.6	101.3	101.3		101.3	101.0	101.3	55.6	56.1
	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TOTAL	0												17.9				17.9
	1					23.8	43.6	45.5	45.5	19.6	19.6		49.6	19.7	19.9	45.5	49.6
	2					50.3	54.6	55.0	55.0	49.1	47.9		79.7	49.1	48.0	55.0	79.7
	3					93.8	97.1	75.7	75.2	92.9	79.3	111.1	110.7	92.9	79.4	77.3	110.6
	4					114.1	146.4	133.0	132.2	113.6	112.4	142.9	142.9	113.6	112.5	135.6	142.8
	5					147.4	149.6	149.6	149.6	149.0	149.1	158.7	167.3	149.0	149.1	153.0	167.3
	6					159.4	159.9	159.9	159.9	159.9	159.1	164.2	192.5	159.9	159.1	160.6	191.6
	7					173.1	165.4	165.4	165.4	169.9	164.2	168.4	201.7	169.9	164.2	166.0	200.8
	8+					189.6	176.3	176.3	176.3	190.3	182.6	185.0	185.0	190.3	182.5	178.0	183.7
	Sum					138.0	159.1	152.1	151.7	137.7	145.0	163.2	129.3	137.7	145.1	154.5	129.5

REPLACEMENT OF MISSING SAMPLES:

SUBDIVISION 22					SUBDIVISION 24				
Missing		Replacement by			Missing		Replacement by		
Gear	Quart.	Area	Gear	Quart.	Gear	Quart.	Area	Gear	Quart.
Trawl	1, 2	24	Trawl	1	Trawl	2	24	Trawl	1
Gillnet	3, 4	22	Gillnet	2	Gillnet	3, 4	24	Gillnet	2
Trapnet	1, 3, 4	22	Trapnet	2	Trapnet	1, 4	24	Trapnet	2

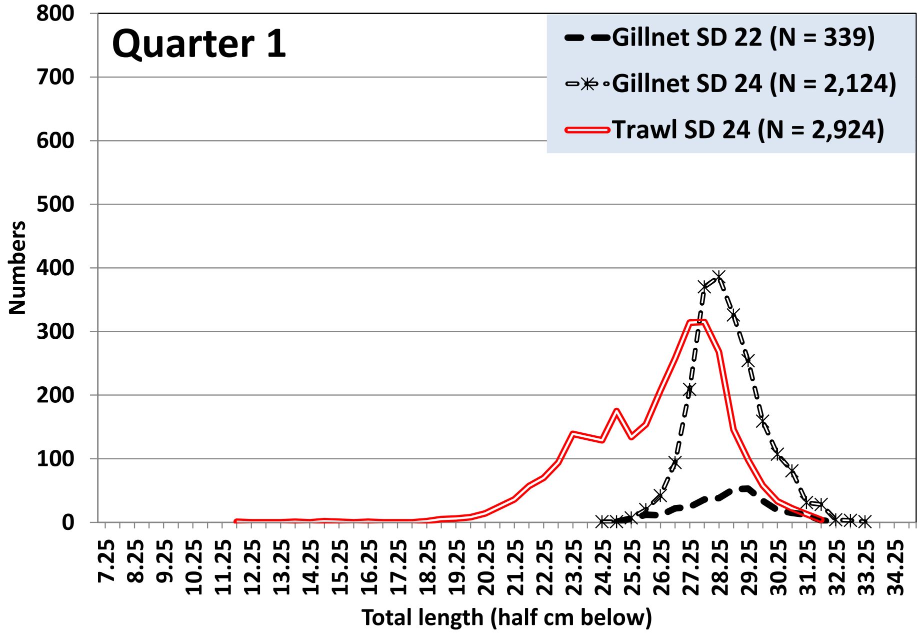
2.4 Mean length (cm) in the catch

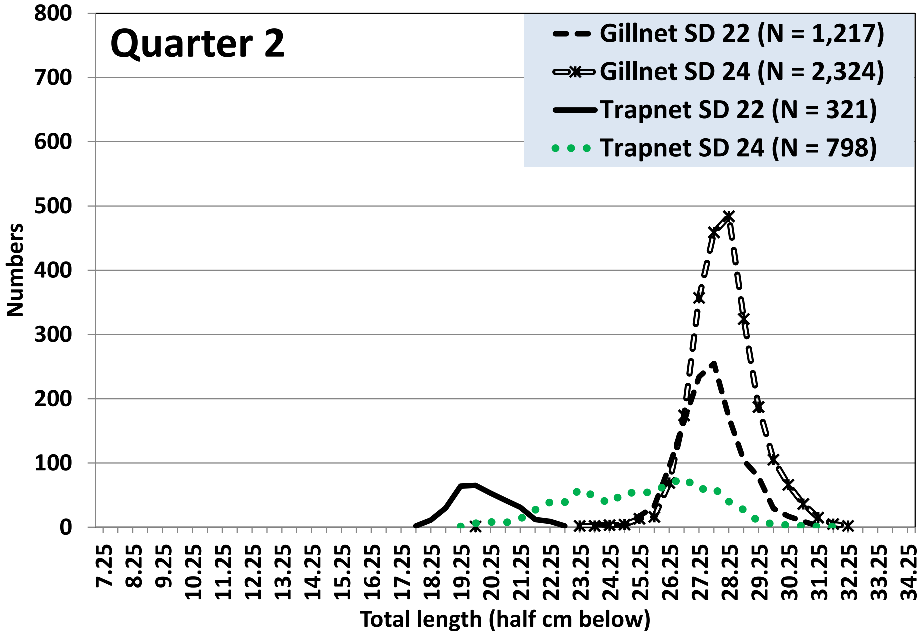
		SUBDIVISION 20				SUBDIVISION 22				SUBDIVISION 24				SUBDIVISIONS 22+24			
	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TRAWL	0												14.2				14.2
	1					14.6	14.6			14.6	14.6		19.6	14.6	14.6		19.6
	2					19.2	19.2			19.2	19.2		22.4	19.2	19.2		22.4
	3					23.5	23.5			23.5	23.5		24.5	23.5	23.5		24.5
	4					24.8	24.8			24.8	24.8		26.4	24.8	24.8		26.4
	5					27.0	27.0			27.0	27.0		27.7	27.0	27.0		27.7
	6					27.6	27.6			27.6	27.6		28.9	27.6	27.6		28.9
	7					28.2	28.2			28.2	28.2		29.6	28.2	28.2		29.6
	8+					29.6	29.6			29.6	29.6			29.6	29.6		
	Sum					26.1	26.1			26.1	26.1		25.2	26.1	26.1		25.2
	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
GILLNET	0																
	1																
	2																
	3					26.9	24.6	24.6	24.6		24.1	24.1	24.1	26.9	24.1	24.6	24.2
	4					26.2	27.1	27.1	27.1	27.4	26.7	26.7	26.7	27.4	26.7	27.0	26.7
	5					26.8	26.9	26.9	26.9	28.0	27.8	27.8	27.8	28.0	27.8	27.3	27.8
	6					28.9	27.6	27.6	27.6	28.8	28.2	28.2	28.2	28.8	28.2	27.7	28.1
	7					29.0	28.0	28.0	28.0	29.2	28.5	28.5	28.5	29.2	28.5	28.1	28.4
	8+					29.4	28.8	28.8	28.8	30.3	29.6	29.6	29.6	30.2	29.6	29.0	29.5
	Sum					28.6	27.7	27.7	27.7	28.5	28.1	28.1	28.1	28.5	28.1	27.8	28.1
	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TRAPNET	0																
	1					18.6	18.6	18.6	18.6					18.6	18.6	18.6	18.6
	2					20.0	20.0	20.0	20.0	19.8	19.8		19.8	19.9	19.8	20.0	20.0
	3					20.8	20.8	20.8	20.8	23.1	23.1		23.1	23.1	23.1	20.8	20.9
	4					21.0	21.0	21.0	21.0	24.9	24.9		24.9	24.9	24.9	21.0	21.1
	5									26.7	26.7		26.7	26.7	26.7		26.7
	6									26.5	26.5		26.5	26.5	26.5		26.5
	7									27.6	27.6		27.6	27.6	27.6		27.6
	8+									28.9	28.9		28.9	28.9	28.9		28.9
	Sum					20.0	20.0	20.0	20.0	25.3	25.3		25.3	25.3	25.3	20.0	20.1
	W-rings	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
TOTAL	0												14.2				
	1					15.3	18.3	18.6	18.6	14.6	14.6		19.6	14.6	14.7	18.6	19.6
	2					19.3	19.9	20.0	20.0	19.2	19.7		22.4	19.2	19.7	20.0	22.4
	3					23.6	23.8	22.1	22.0	23.5	23.2	24.1	24.4	23.5	23.2	22.2	24.4
	4					24.8	26.5	25.9	25.8	24.8	25.4	26.7	26.4	24.8	25.4	26.1	26.4
	5					26.9	27.8	26.9	26.9	27.0	27.5	27.8	27.7	27.0	27.5	27.3	27.7
	6					27.7	28.2	27.6	27.6	27.7	28.0	28.2	28.8	27.7	28.0	27.7	28.8
	7					28.5	28.5	28.0	28.0	28.4	28.4	28.5	29.5	28.4	28.4	28.1	29.4
	8+					29.5	29.6	28.8	28.8	29.7	29.5	29.6	29.6	29.7	29.5	29.0	29.5
	Sum					26.3	28.1	27.1	27.0	26.3	27.2	28.1	25.3	26.3	27.2	27.3	25.3

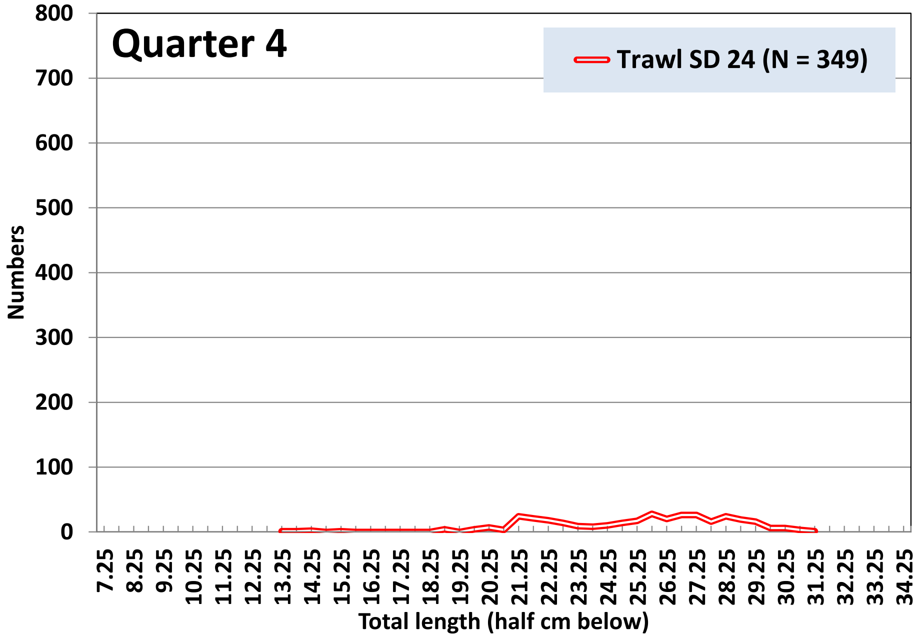
REPLACEMENT OF MISSING SAMPLES:

SUBDIVISION 22					SUBDIVISION 24				
Missing		Replacement by			Missing		Replacement by		
Gear	Quart.	Area	Gear	Quart.	Gear	Quart.	Area	Gear	Quart.
Trawl	1, 2	24	Trawl	1	Trawl	2	24	Trawl	1
Gillnet	3, 4	22	Gillnet	2	Gillnet	3, 4	24	Gillnet	2
Trapnet	1, 3, 4	22	Trapnet	2	Trapnet	1, 4	24	Trapnet	2

2.5 Sampled length distributions by Subdivision, quarter and type of gear







PFA self-sampling report for HAWG 2015-2018

Martin Pastoors, 20/03/2019 17:18:46

1 Introduction

The Pelagic Freezer-trawler Association (PFA) is an association that has ten member companies that together operate 19 (in 2017) freezer trawlers in six European countries (www.pelagicfish.eu). In 2015, the PFA has initiated a self-sampling programme that expands the ongoing monitoring programmes on board of pelagic freezer-trawlers by the specialized crew of the vessels. The primary objective of that monitoring programme is to assess the quality of fish. The expansion in the self-sampling programme consists of recording of haul information, recording the species compositions per haul and regularly taking random length-samples from the catch. The self-sampling is carried out by the vessel quality managers on board of the vessels, who have a long experience in assessing the quality of fish, and by the skippers/officers with respect to the haul information. The scientific coordination of the self-sampling programme is carried out by Martin Pastoors (PFA chief science officer) with support of Floor Quirijns (contractor).

2 Overview of self-sampling methodology

The self-sampling programme is designed in such a way that it follows as closely as possible the working practices on board of the different vessels and that it delivers the information needed for the SPRFMO Science Committee. The following main elements can be distinguished in the self-sampling protocol:

- haul information (date, time, position, weather conditions, environmental conditions, gear attributed, estimated catch, optionally: species composition)
- batch information (total catch per batch=production unit, including variables like species, average size, average weight, fat content, gonads y/n and stomach fill)
- linking haul and batch information (how much of a batch is caught in which of the hauls) or estimating species proportion per haul
- length frequency measurements, either by batch or by haul

The self-sampling information is collected using standardized Excel worksheets. Each participating vessel will send in the information collected during a trip by the end of the trip. The data will be checked and added to the database by Floor Quirijns and/or Martin Pastoors, who will also generate standardized trip reports (using RMarkdown) which will be sent back to the vessel within one or two days. The compiled data for all vessels is being used for specific purposes, e.g. reporting to expert groups, addressing specific fishery or biological questions and supporting detailed biological studies. The PFA publishes an annual report on the self-sampling programme.

An important feature of the PFA self-sampling programme is that it is tuned to the capacity of the vessel-crew to collect certain kinds of data. Depending on the number of crew and the space available on the vessel, certain types of measurements can or cannot be carried out. That is why the programme is essentially tuned to each vessel separately. And that is also the reason that the totals presented in this report can be somewhat different dependent on which variable is used. For example the estimate of total catch is different from the sum of the catch per species because not all vessels have supplied data on the species composition of the catch on all trips.

Because the self-sampling programme has been under development over the years, different numbers of vessels have been participating in the programme over different years. Results should not be interpreted as a census of the PFA fleet, but rather as an indicator of relative distributions and samples of catch and catch compositions.

3 Results

3.1 Vessels, fisheries, trips and catch in all areas

An overview of all the self-sampling trips in 2015-2018 (and the beginning of 2019) and in which the total catch of herring and sprat was at least 250 tonnes, is shown in the table below. Overall, an expansion of the number of participating vessels in the self-sampling has lead to larger number of trips and higher catches being included in the sampling. The selected trips equated to 5.910^{4} tonnes of catch in 2015 and increased to 2.0610^{5} tonnes in 2018.

year	nvessels	ntrips	ndays	nhauls	catch	nlength

2015	4	19	338	837	58,892	57,559
2016	9	38	549	1,426	135,098	50,445
2017	11	38	551	1,415	123,091	62,993
2018	16	68	1,040	2,537	205,579	102,750
(all)	.	163	2,478	6,215	522,660	273,747

year	catch/trip	catch/day	catch/haul
2015	3,099	174	70
2016	3,555	246	94
2017	3,239	223	86
2018	3,023	197	81
(all)	.	.	.

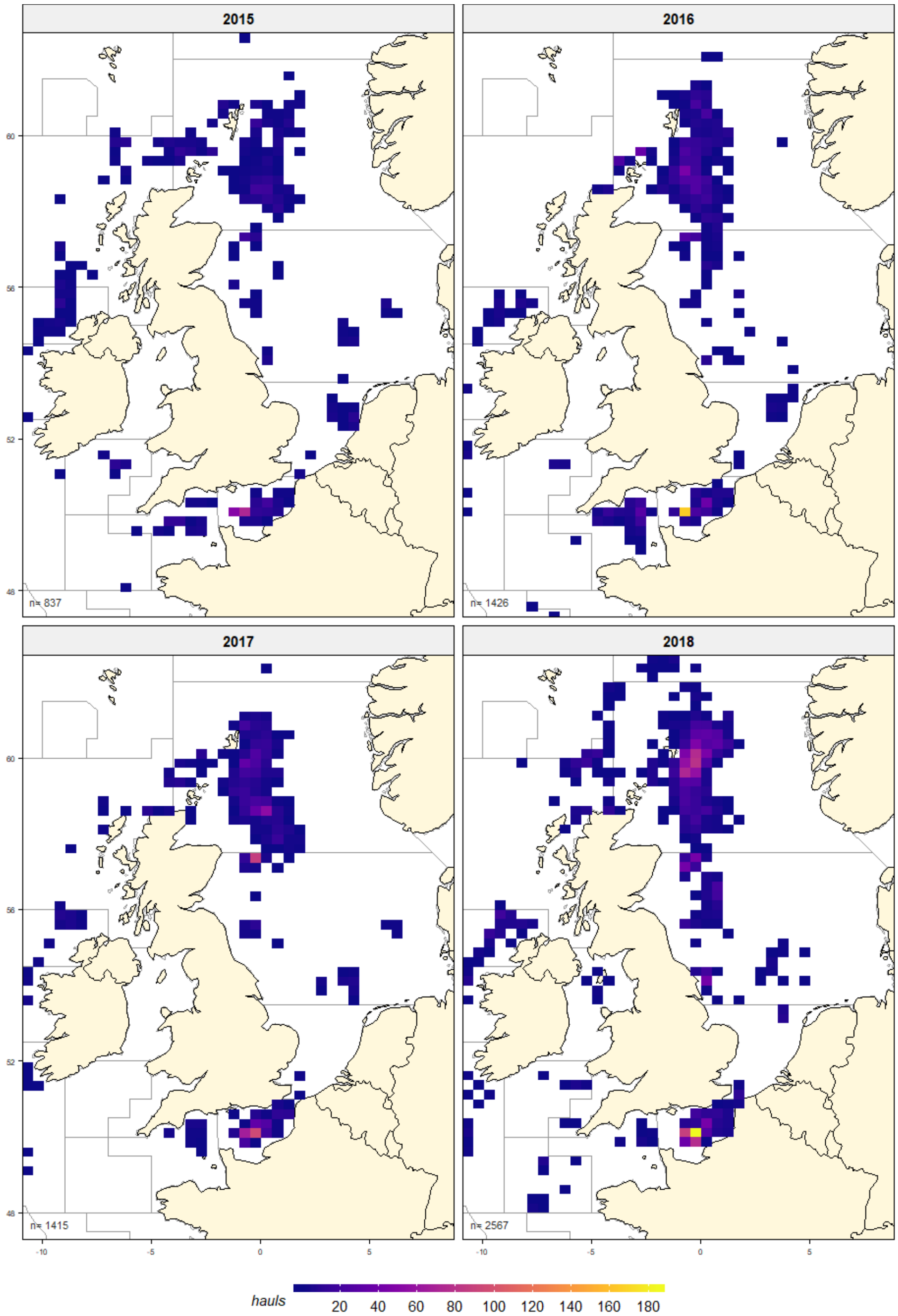
Table 1.1.1: PFA selfsampling summary of herring and sprat trips (>250 ton) with the number of days, hauls, trips, vessels, catch (tonnes), number of fish measured and average catch rates (ton/trip, ton/day, ton/haul). The asterisk indicates a partial year.

Species compositions in self-sampled fisheries.

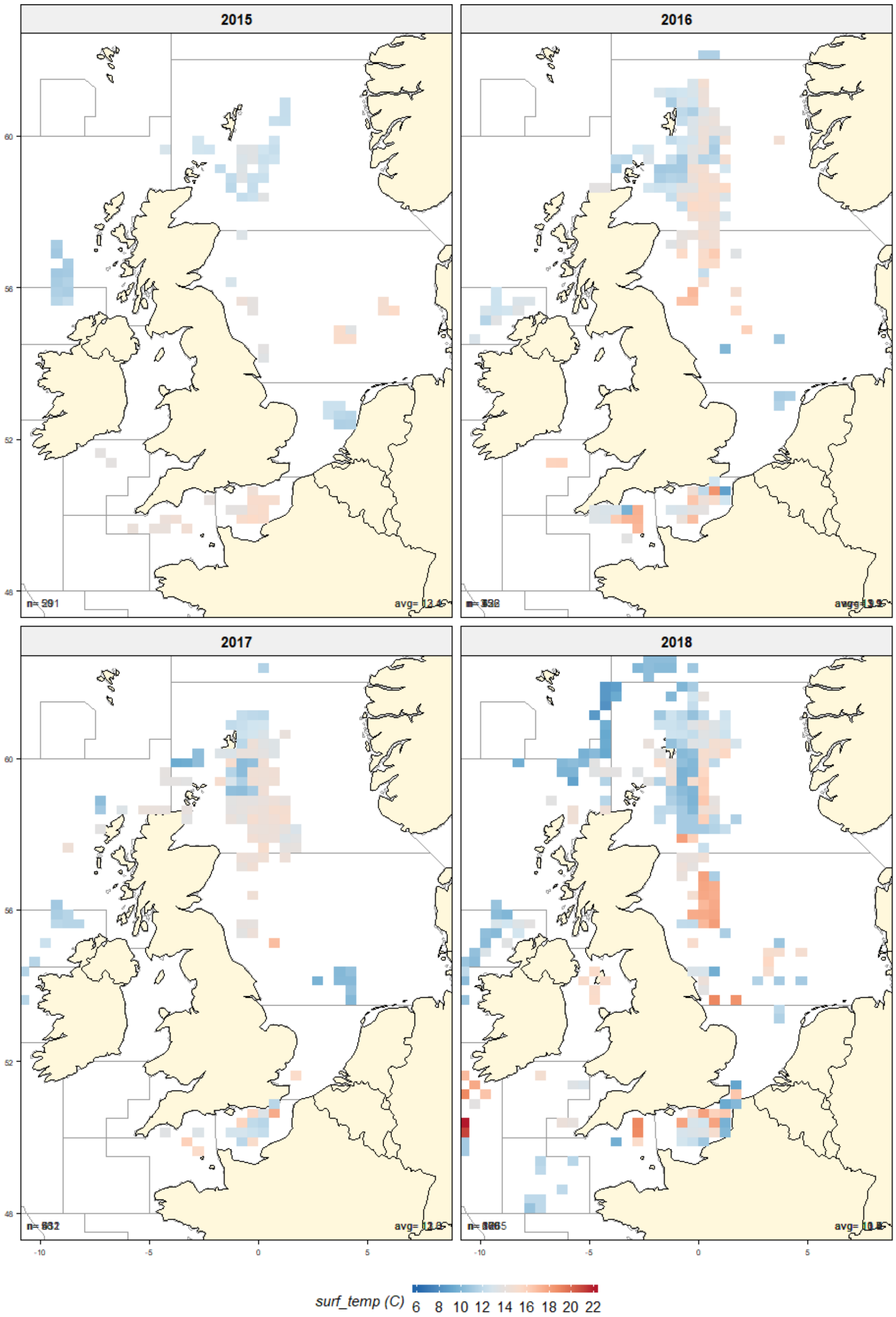
species	englishname	scientificname	2015	2016	2017	2018	all
her	herring	Clupea harengus	36,143	80,535	79,790	157,485	353,953
spr	sprat	Sprattus sprattus	1,570	139	1,059	1,013	3,782
oth	NA	NA	13,747	17,559	14,234	40,477	86,017
(all)	(all)	(all)	51,461	98,233	95,084	198,975	443,753

Table 2.1.1: Total catch (tonnes) by species in PFA self-sampled fisheries. Target species and other species. The asterisk indicates a partial year

An overview of all self-sampled hauls during trips when a certain amount of herring and sprat were caught during a trip (>250 tonnes).



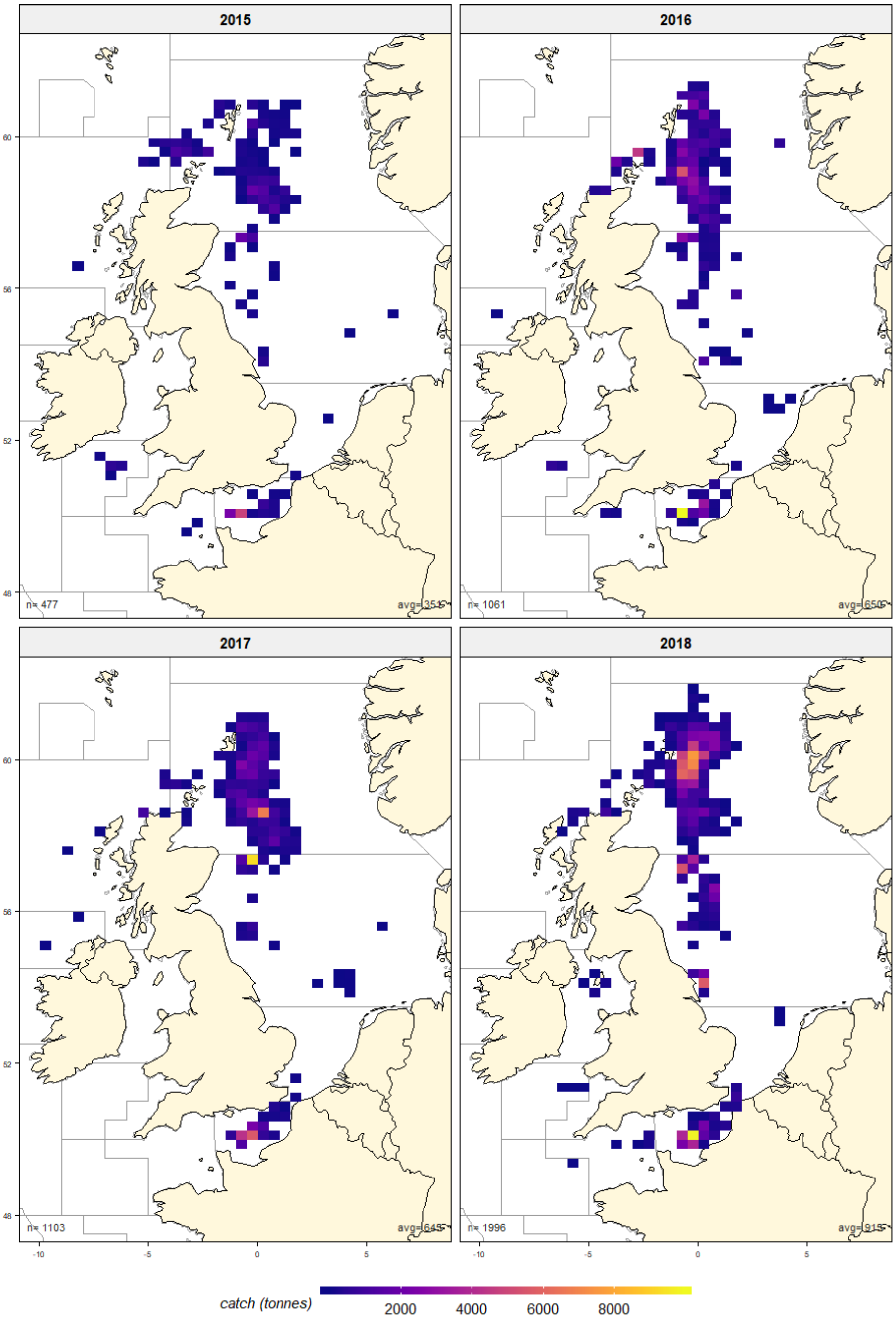
Haul positions in PFA self-sampled fisheries for herring and sprat.


2015
2016
2017
2018
surf_temp (C)
6 8 10 12 14 16 18 20 22

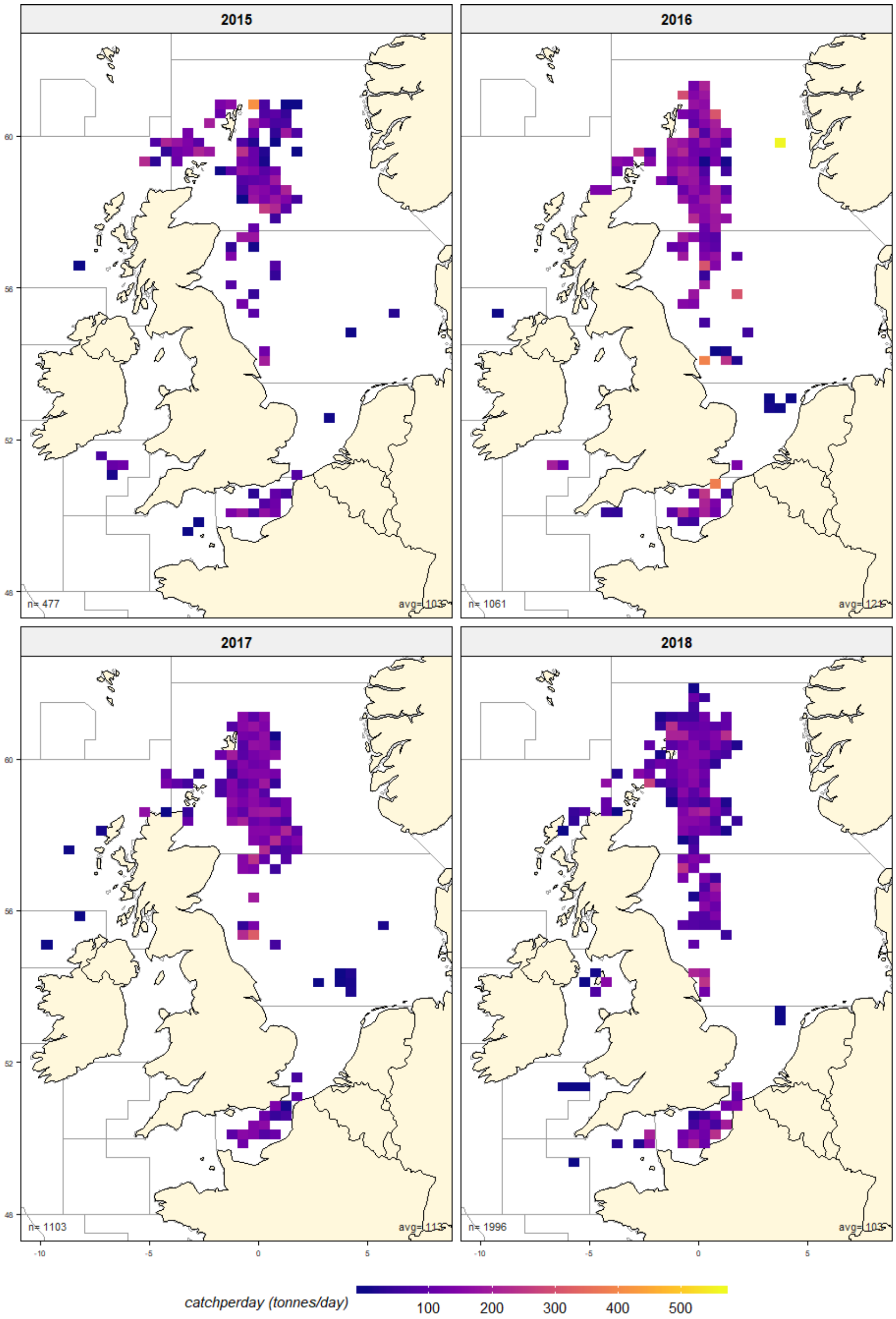
Herring (Clupea harengus) in area 27

year	nvessels	ntrips	ndays	nhauls	catch	nlength
2015	4	18	195	478	38,834	39,223
2016	9	38	419	1,063	105,665	37,484
2017	11	38	422	1,106	99,624	48,885
2018	16	68	747	1,971	163,973	82,234
(all)	.	162	1,783	4,618	408,096	207,826

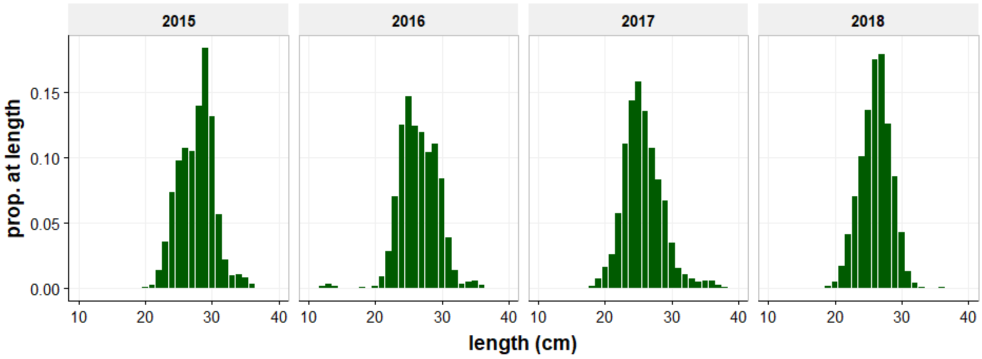
Herring catch by year



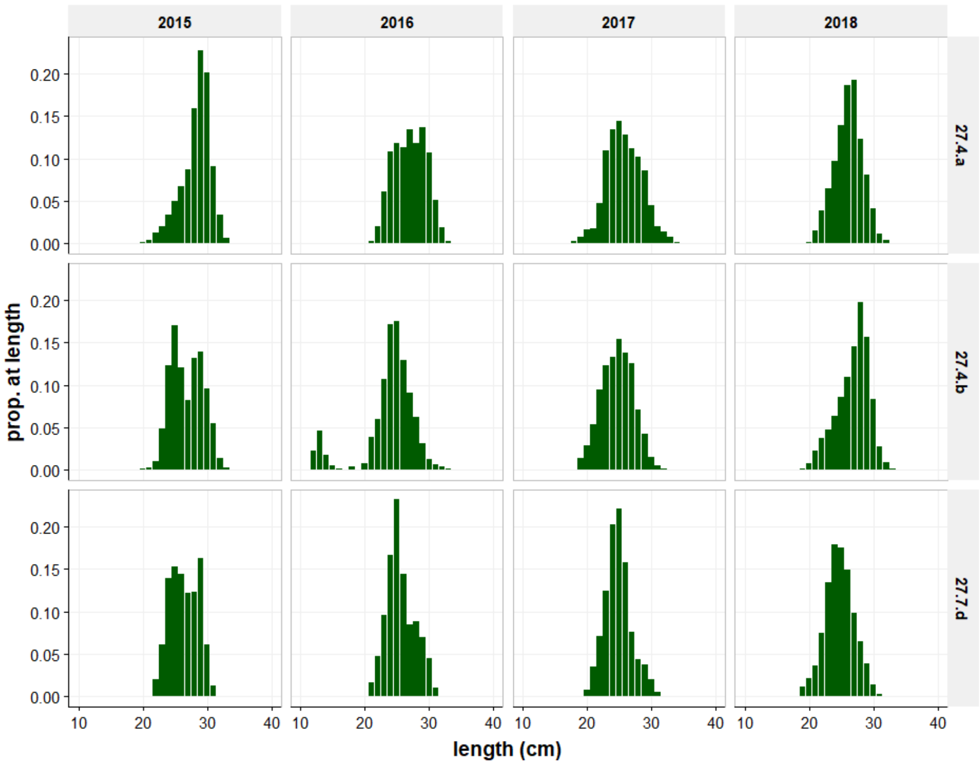
Herring catch/day by year



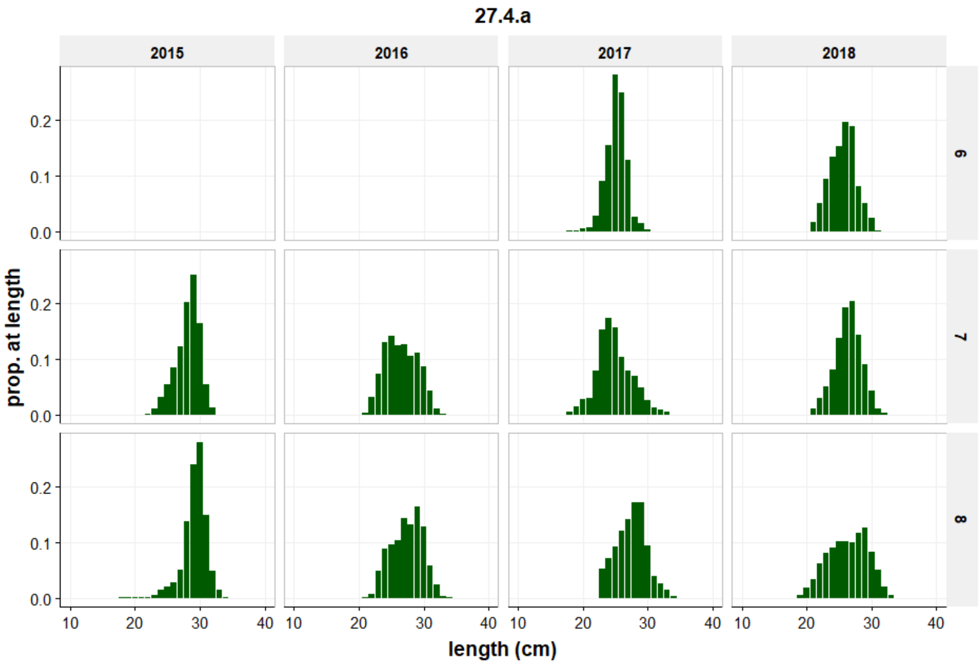
Herring length compositions by year



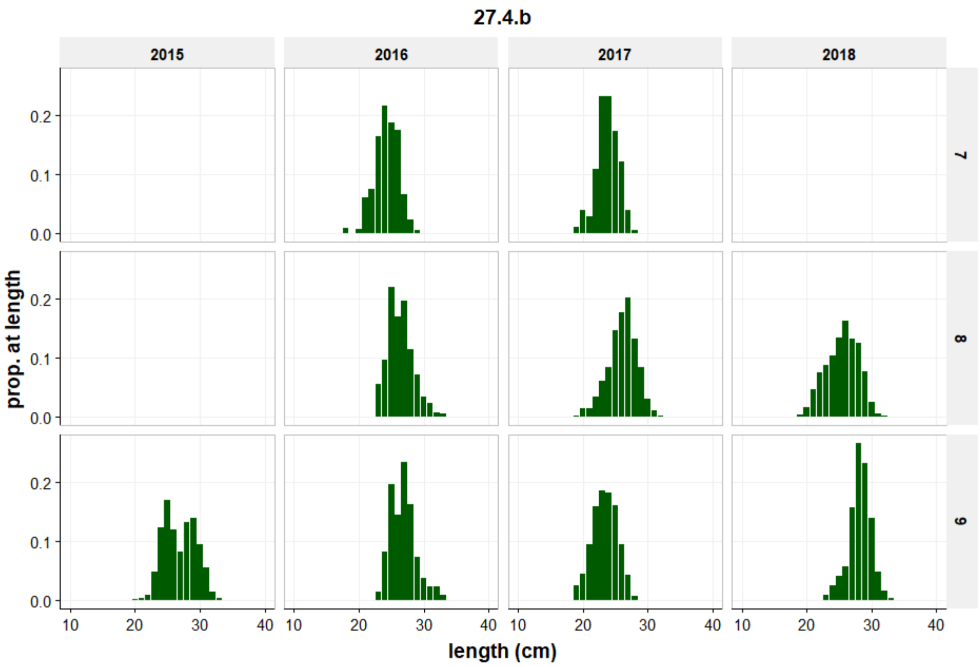
Herring length compositions by division and year



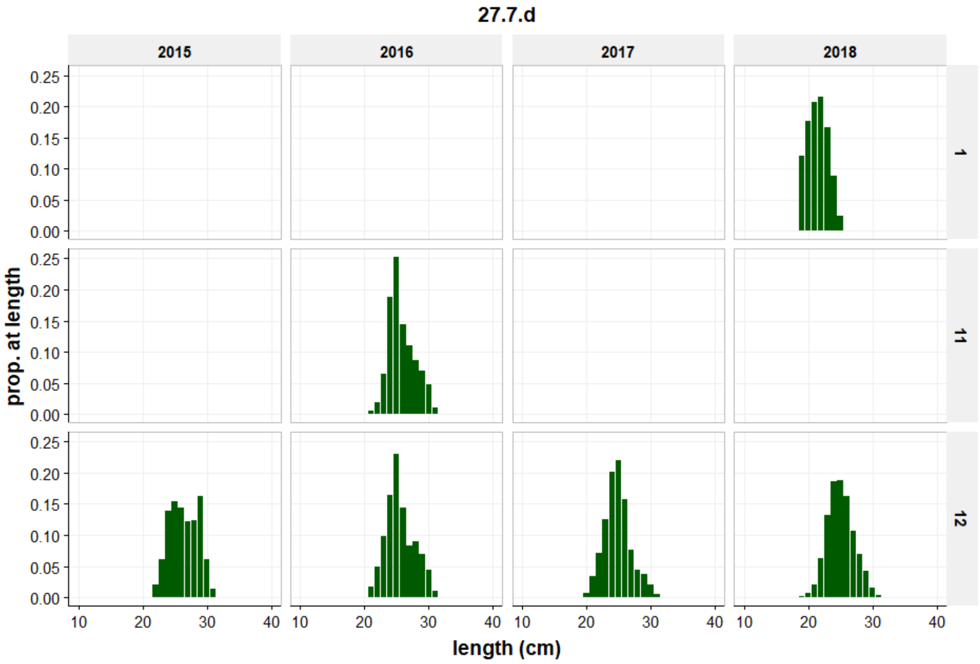
Herring length composition year and month for division 27.4.a in months 6, 7 and 8.



Herring length composition year and month for division 27.4.b in months 7, 8 and 9,



Herring length composition year and month for division 27.7.d in months 1, 11 and 12,

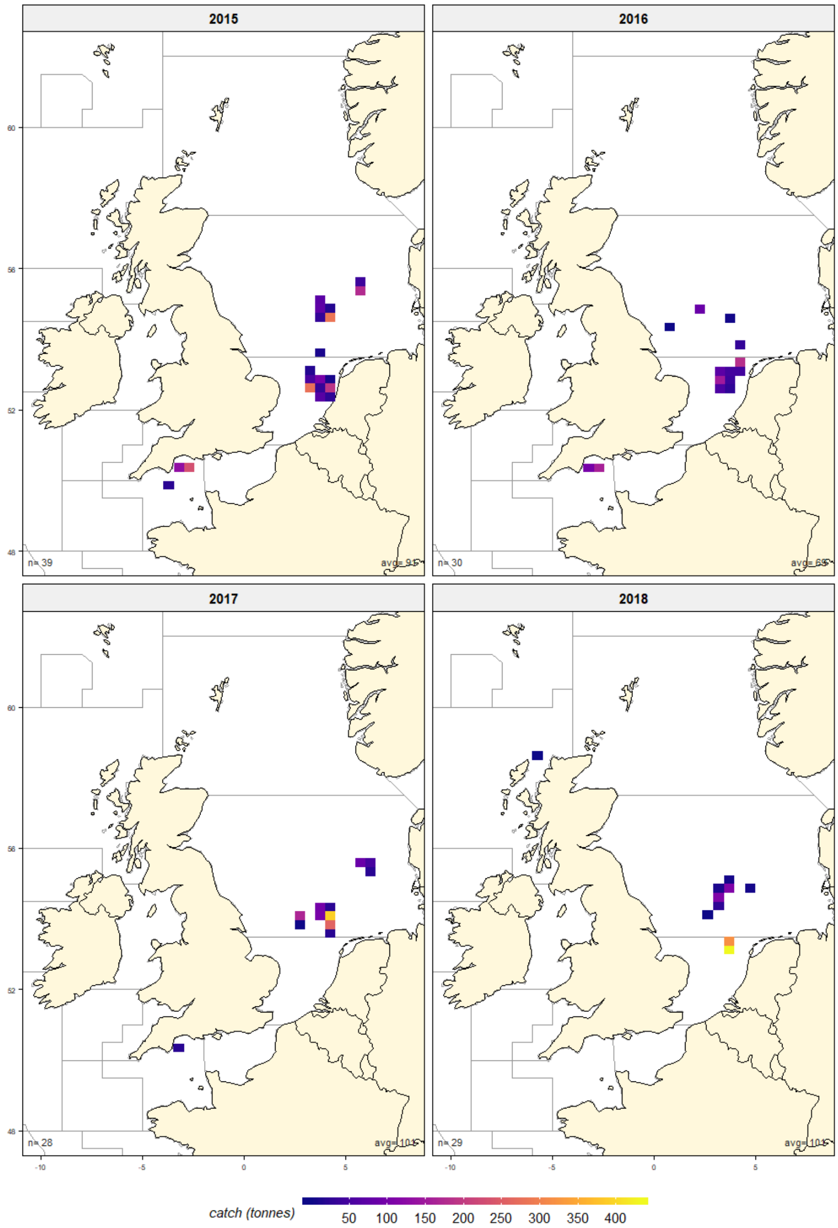


27.7.d
2015
2016
2017
2018
1
11
12
prop. at length
0.00
0.05
0.10
0.15
0.20
0.25
10
20
30
40
length (cm)

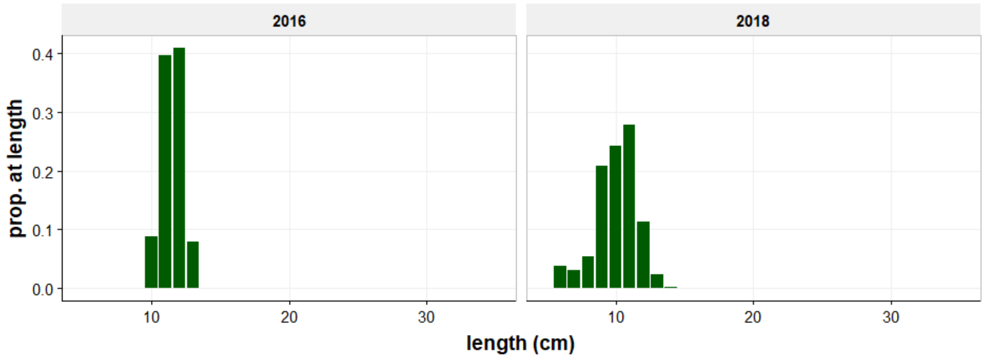
Sprat (Sprattus sprattus) in area 27

year	nvessels	ntrips	ndays	nhauls	catch	nlength
2015	3	6	21	39	1,828	0
2016	3	6	15	30	978	156
2017	3	3	11	28	1,221	0
2018	4	5	11	29	1,011	2,318
(all)	.	20	58	126	5,038	2,474

Sprat catch by year



Sprat length compositions by year (limited length sampling available)



4 Discussion and conclusions

By the end of 2018, 16 vessels had been participating in the PFA self-sampling programme in the Northeast Atlantic in one way or another. This is about 89% of the freezer-trawler fleet. Although the programme does not consist of a random selection of vessels – because the instructions to the vessel benefit from a continued application of data collection on the participating vessels – the overall fishing pattern does appear to represent the fisheries of the PFA vessels.

The information in this report is only supplied for the fisheries that targetted herring or sprat, where the total catch of herring and sprat was at least 250 tonnes per trip.

In this year's report, the focus is more on the length compositions by year, area and month. Ideally, and for the future, one could expect that links will be generated between the age-length sampling that is part of the European data collection programme and the PFA self-sampling programme.

We believe that the direct communication of the results of the self-sampling programme with the participating crews and vessels is a key element of the programme. Maintaining engagement with the fishermen at sea is an essential requisite for the programme to work. Direct communication involves an almost instantaneous return of the trip report after finishing a trip.

Overall the self-sampling programme demonstrates the feasibility of self-documenting catches of this fleet and providing links between environmental parameters and catches.

5 Acknowledgements

The skippers, officers and the quality managers of many of the PFA vessels have put in a lot of effort to make the PFA the self-sampling work. Without their efforts, there would be no self-sampling.

6 More information

Please contact Martin Pastoors (mpastoors@pelagicfish.eu) if you would have any questions on the PFA self-sampling programme or the specific results presented here.