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Northern Shrimp (*Pandalus borealis*) on Flemish Cap Surveys 2020

by

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**Abstract**

A stratified random bottom trawl survey on Flemish Cap was carried out from June 24<sup>th</sup> to August 4<sup>th</sup> 2020. The area surveyed was extended up to depths of 800 fathoms (1450 meters) following the same procedures as in previous years. This year a total of 181 valid hauls were made by the vessel *R/V Vizconde de Eza* with the usual survey gear (Lofoten), 120 up to 730 meters depth. The surveyed area has properly prospected the 32 strata planned. The general indexes for shrimp were estimated taken into account the traditional swept area (strata 1-19, up to depths of 730 m.) and the total area surveyed (strata 1-34, up to depths of 1450 m.). As the last years the strata 26 and 27 sited in the southeast of the bank with depths from 600 to 800 fathoms (1100-1400 m.) will not be surveyed due to the presence in the bottoms of great quantities of mud and sponges.

The results concerning shrimp are presented and compared to those from previous years of the same series. The total biomass index decreased 27%, breaking the upward trend of recent years. Despite the decrease in biomass the stock continue above *B<sub>lim</sub>* and it is from 2018 outside the collapse zone defined by the NAFO PA framework. The total and female biomass indexes were 6 734 t and 6 048 t respectively. As in previous years the youngest specimens (age 1, around 10 mm CL) barely appeared in the catches and the abundance at age 2 from the main gear increased around 19% from 2019. This increase at age 2 was very higher from the small bag attached on the cod-end where was recorded the second highest value in the survey series that it could confirm the upward trend in the recent recruitments initiated from 2014. However unlike 2019 the abundance at age 1 in the small mesh size bag attached on the cod-end was below average in the series. Considering the overall increasing trend of the stock from 2014 above *B<sub>lim</sub>* and the uncertainty about the future recruitments in the fishable stock the next years, Scientific Council agrees not to change the advice from last year and that the catch in 2021 should not exceed the 2009 level (5 448 tonnes).

**Introduction**

The aim of this paper is to show the results about shrimp obtained in the summer bottom trawl surveys in Flemish Cap (NAFO Regulatory Area of Div. 3M) in 2020. Also they are compared with that obtained between years 2003-2017 by the *R/V Vizconde de Eza*, and with the transformed series previous to 2003 obtained by the *R/V Cornide de Saavedra*.



## Material and Methods

### Survey design and gear used

The surveys on Flemish Cap (NAFO Regulatory Area of Div. 3M) was initiated by UE in 1988 and carried out in summer (June-July), on board the Spanish Research vessel R/V *Cornide de Saavedra* until 2002 year. Since 2003, the R/V *Cornide de Saavedra* was replaced by the R/V *Vizconde de Eza*. The gear used was a bottom trawl net type Lofoten during the whole of period.

In 2020 the survey was carried out from June 24<sup>th</sup> to August 4<sup>th</sup>. The area prospected in Flemish Cap was spread up to 1450 meters. In 2020 as in previous years the strata 26 and 27 in the southeast of the Flemish Cap with depths between 1095 and 1450 m. were not prospected due to the presence in the bottoms of great quantities of mud and sponges. Also the hauls were carried out outside of the closed areas by presence of VME following the SC recommendation. The haul number carried out in the traditional 19 strata with depths minor than 740 m. was of 120. The area with depths higher than 740 m. was sampled by means of 61 additional hauls proportionally distributed in the new 13 strata.

The bottom trawl surveys followed the same procedures as in previous years. The specifications about the main technical data of the survey are described in Table 1.

### Sampling

Wherever it was possible samples of approximately 1.5 kilogram shrimp were taken in each tow where this species was present for length frequency determination. Also, some samples were frozen for length-weight analysis in the laboratory.

Shrimps were separated into males and females according to the endopod of the first pleopod (Rasmussen, 1953). Individuals changing sex phase, according to this criterion, were included as females. Females were further separated as primiparous (first time spawners) and multiparous (spawned previously) based on the condition of the external spines (McCrory, 1971). Ovigerous females were considered as a group and were not included with multiparous females.

Oblique carapace length (CL), the distance from the base of the eye to the posterior dorsal edge of the carapace (Shumway *et al.*, 1985), was measured to the lower 0.5 mm length-classes. Sampling length data were used to obtain an estimate of population length distributions in the whole area and to compare it with the estimates of the other years.

### Sex reversal ( $L_{50F}$ ) and length at maturity ( $L_{50MF}$ )

In order to analyze changes in the length at maturity, from each length class the proportion ( $\pi_i$ ) of mature females against all specimens was calculated. The method used to estimate the maturity ogive and the length where the 50% of the specimens are mature females ( $L_{50MF}$ ) was based on fitting of the sigmoid, so-called logistic curve.

The equation used was

$$Y = 1/(1+e^{-(a+bx)}).$$

With a y b being the intercept and slope respectively of the regression  $\ln(\pi_i/1-\pi_i)$  on length class.

The logistic curve was fitted each year using a non-linear method to estimate the parameters by iteratively minimizing the sum of squares of the deviations between observed and predicted proportions where the mature females were presents.

In the same way the sex ratio by length classes were estimated to obtain the length at sex change where 50% of the specimens are females ( $L_{50F}$ ).

### Age composition and MIX program

The length frequency distribution by sex group were analysed by package for fitting finite mixture distribution *Rmix* and the proportion, mean lengths and standard deviations of the mean length (sigma) are calculated for each age component and sex group. When the modal components overlap and obscure one another, was necessary to reduce the number of parameters estimated in order to get the best and reasonable adjust. We have constrained sigma very often fixing the coefficient of variation (FCV) at 0.045 or keeping it constant (CCV).

After getting the proportions and mean lengths for every age/sex group the results were used to calculate the total number of individuals in every age/sex group according to the biomass estimate. This was done by transforming the CL to weight using the weight length relationship estimated each year during the survey. So, the mean lengths were converted to mean weights to calculate the number of males, primiparous females and multiparous females (Skúladóttir and Diaz, 2001).

### Small mesh size bag on the cod-end

Knowing that mean size of shrimp coincides with the selection range of the 35 mm mesh currently used, a bag with 10 mm mesh size was attached as last years to the cod-end of the Lofoten gear, just in a position where escapement is believed to be the highest. The base of the bag was a square of 36 cm in each side. The whole shrimp caught in the juvenile bag was weighed and measured.

## Results

### Biomass

This year a total of 181 valid bottom trawls were completed with Lofoten trawl gear in Flemish Cap survey, 120 of them were carried out in the traditional strata prospected from 1988 with depths up to 740 m. (400 fms.) (Fig. 1).

Total shrimp biomass, estimated by swept area method and mean catch per tow from 1988 to 2020 are presented in Table 2. The values presented from 1988 to 2002 year are those resultants of the Warren's transformation of the lengths distribution obtained by the R/V *Cornide Saavedra* and the length-weight relationship estimated every year (Casas *et al.* 2005).

The increasing of biomass since 1988 to 1992, coincided with a period of time where there was not a directed fishery to shrimp and the cod stock began to decline. With the beginning of the shrimp fishery in 1993 the shrimp biomass declined up to 1997. After that the stock recovered reasonably well although with high annual variability (historical maximums in 2002 and 2005 were followed by years with lower biomass but at a relative high level). In 2009 the biomass decreased sharply with values close to the lowest of the historical series in that year. In 2010 despite of the biomass increase about 77% compared to 2009 this was still among the lowest in the total of the historical series. From 2011 the total biomass decreased successively and were recorded the lowest values in the series showing the worsening and depletion state of the shrimp stock. Since 2015 the biomass indexes increased year after year and they are above  $B_{lim}$  from 2018 (Figure 2). The total and female biomasses estimated in 2020 were 6 734 t and 6 048 t respectively (Table 2).

Biomass estimated by depth strata from 1988 to 2020 is shown in Table 3. The presence of shrimp in shallowest strata, with depths less than 140 fathoms (257 m), was scarce in the first years (1988-1995). However, from 1996, a noticeable amount of shrimp occurred in these strata and the estimated biomass increased up to 2002 and 2003 years where the 36% and 41% respectively of the total biomass were estimated in depths lesser than 140 fathoms. After these years the biomass estimated in these depths declined each year and from 2008 to 2011 they were residual (0.1% of the total biomass in 2011). In 2012 the biomass

in these strata increased strongly (20%) mainly due to the presence of shrimp in only one tow in the shallowest strata (70-80 fth.). Since 2013, the biomass has once again been among the lowest recorded (< 2%). According to this, the catch distributions observed during the 2020 survey (Fig. 3) showed a patched distribution around the central area of the bank but with greater presence (69% of the biomass) in depth strata (201-300 fth.).

### **Adult stock, female biomass**

Total biomass estimates by the series of bottom trawl surveys on Flemish Cap from 1988 to 2020 (Table 2 and Fig. 2) are quite variable, due to the predominant sizes of the shrimp are in the selection range of the cod-end mesh size used (35 mm), so the biomass estimations are clearly affected by small changes in cod-end mesh size between years. To solve this problem it was proposed to use the shrimp bigger than 20 mm CL (Table 2). The biomass for shrimp bigger than 20 mm CL tried to be an index of the adult biomass not affected by differences in the cod-end mesh size used. The 20 mm CL was chosen because it is approximately the limit between 3 and 4 years old shrimp in this season (Garabana, 1999). The biomass estimated for shrimp bigger than 20 mm in 2020 was 5 444 t.

The use of female biomass estimate is also an index not affected by small changes in mesh size, and it is the one used by the NAFO Scientific Council, so it was also included in Table 2. In 2020 the estimated female biomass (6 048 t) was about 29 % lower than 2019 and it is now below the average value of the EU survey series.

The standard gear used in the surveys was a Lofoten with a cod-end mesh size of 35 mm with the exception of the 1994 and 1998 surveys when a 40 mm and 25 mm cod-end mesh size were used respectively. Consequently, the biomass index in 1994 is supposed to be underestimated and that of 1998 could have been overestimated by a factor of two (del Río, 1998).

In the figure 2 the adult biomass estimates are compared with the total biomass and female biomass along the series. Differences between these quantities in every year correspond to the greater or smaller catch of young shrimp. These differences are showed as percentage of the total biomass in the figure 4 and from the male and shrimps smaller than 20mm CL percentages (Table 5). Although the smaller size-classes are more directly affected by small changes in the cod-end mesh size, the differences between the total biomass and the adult biomass (>20 mm.) showed an increasing trend in the period 1988-2005 from 6% in the beginning of the series to 56% in 2005. Since 2006 the increasing trend changes and difference between total biomass and adult biomass decreases to levels prior 1997 year. The male percentages along the years showed a similar picture. The high value estimated in 1998 was due to the lesser mesh size of the linner codend used (25 mm.), and not comparable conclusions can be thrown.

The decrease in the length at sex change is a general trend from 1992 to 2006 (Fig.5a). After that the length at sex change increased year after year up to 2010 (20 mm.), varied without trend between 2010 and 2017 and decreased in 2019 and 2020 to the lowest value in the historical series (18.1 mm). The length at maturity ( $L_{50MF}$ ) (Fig. 5b), showed a similar and decreasing trend until 2006. After that year the  $L_{50MF}$  showed an increasing trend reaching in 2015 26.8 mm. Since then the length at maturity have decreased around 2009-2010 levels.

### **Length frequencies**

The length frequencies and percentages by sex for 2020 are shown in the Table 4. These length frequencies are split into males, primiparous females, multiparous females and ovigerous.

The Fig. 6 shows the length distribution by sex on EU Flemish cap 2005-2020 surveys. With the exception of 1998, where a lesser mesh size was used in the survey (25 mm.), the most important modal size in the historical series occurred in 2002 and 2005 around 18 mm and 16.5 mm CL respectively. The importance of the youngest individuals decreased markedly from 2006 and since 2009 the lack of strong year classes and the successive bad recruitments caused a drastic fall in the frequencies of practically all the length groups compared with those obtained in previous years. The biomass estimated in 2020 was mainly represented by female and big

specimens with sizes around 19-27 mm (Figure 8). Young specimens (mainly males) increased (around 15% in number) compared to 2019 but remain well below average.

The shrimp length distribution estimated in the surveys since 1988 with the Lofoten gear did not record adequately the small size groups in the beginning of the historical series. Since 1996 the age 2 has been present in the catches in a significant way and the introduction of the new vessel in 2003 improved the catchability of this age; mainly due to the technological advances in maintaining more stable the performance of the fishing gear.

Since 2001 the routine use of a small mesh size bag attached to the cod-end to collect a portion of the small size shrimp escaping through the meshes was a common alternative. The estimated biomass and length distributions obtained with the small mesh size bag in 2020 survey are presented in Table 6. The estimated biomass was 45 t and the length distribution showed two clear modes at 8 mm and 14 mm CL, corresponding to age-classes 1-2 respectively (Table 7 and Fig. 7). The higher mode from age-class 2 (around 13 mm) shows a comparative stronger year class (2018) that could improve the weak recruitments of the last years.

### Age structure

The Table 7 and the Figures 7 y 8 show preliminary and visual interpretation of shrimp modal groups and ages from the length distribution obtained by the gear Lofoten and juvenile bag used in 2020.

Age assessment was carried out using the Rmix library from the shrimp length distributions estimated every year in the survey series. The result of the modal analysis for annual survey 2020 is shown in Table 8. The proportions within each sex group are listed as well as mean lengths and standard deviation (sigma) by age-classes.

The results of Table 8 were then used to calculate the mean length, abundance and biomass at age Tables 9, 10 and 11. The modal analysis in 2020 identified 6 age groups (ages 2 to 7). The age at sex change was smaller than in previous years (3 years old with 18.1 mm CL). The total biomass in 2020 decreased 27% compared to 2019 and the estimated values by age remain at low level.

At the beginning of the series (1988-1995) the youngest shrimp were considered to be three year olds with lengths between 15.4 and 18.2 mm. Since 1996 shrimps with two years old have been present and the lengths ranged between 12.5 to 17.6 mm. The shrimps with one year old appeared at first time in 1998 and were present up to 2003 with lengths around 10 mm. In spite of the variability of the length by age along the years, from the beginning of the series to 2007 it can be observed a decreasing trend in the mean length of the main age groups (Fig. 9). This trend was mainly pronounced from 2004 to 2007, due to the presence in these years of the strong 2002 year class with mean lengths at age below average. From 2007 this trend changed and the mean lengths at age increase up to 2010. Since then the mean lengths have been changing without a clear trend at different ages.

Some strong year-classes may be followed according the abundance by age groups from 1988 to 2006 (Table 10). If the assignation of the age is right, the 1986 year-class stand out in the beginning of historical series with 5 and 6 years old in the years 1991 and 1992. The individuals with 4 year olds were also especially abundant in the years 1999-2002 indicating the strong of year-classes 1995, 1996, 1997 and 1998. The 1999 year-class stand out especially judging by the high number of 3 and 6 year olds in 2002 and 2005 years respectively. In these two years both the biomass and the abundance reached out the highest values in the series, especially in 2005 where the strong 2002 year class with 3 years old was also present. From 2004 the residual presence of age group 1 in the catches and very low values for the ages 2 and 3 showed the absence of strong year classes between 2004 and 2018.

Considering the abundance at age 2 as indicator of recruitment, the number of shrimp of two years old in the survey and from juvenile bag (Table 8) were estimated and the index average-weighted (Fig. 10 and Table 12). Since 2005, the survey indices from Lofoten gear have showed high variability in the estimated values but at lower level than in previous years, confirming the absence of strong year classes. A similar trend can be

observed from juvenile bag's indexes. However, although the recruitments (age 2) has been rather weak since 2014, they have increased and allowed the recovery of the stock. Also the significant increase of shrimps with one year old recorded from the juvenile bag in 2019 seems to be confirmed in 2020 indicating the entry of a relative strong year-class 2018 (age 2 in 2020) that it could improve the recruitment in the fishable stock in 2021 and 2022 (age 3 and 4 respectively) (Fig. 11 and Table 13).

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**Table 1.** Technical data of bottom trawl research surveys on EU Flemish Cap 2020.

| Procedure                                      |                        | Specification  |
|--|------------------------|--|
| Vessel   |                        | <i>R/V Vizconde de Eza</i>                                       |
|  | GT                     | 1 400 t  |
|  | Power                  | 1 800 HP   |
|  | Maximum trawling depth | 1 450 m  |
|  | Trawl winch            | Automatic control on warp tension                                |
| Mean trawling speed                            |                        | 3-3.5 knots  |
| Trawling time                                  |                        | 30 minutes effective time  |
| Fishing gear                                   |                        | type <i>Lofoten</i>  |
|  | footrope / handrope    | 31.20 / 17.70 m  |
|  | footgear               | 27 steel bobbins of 35 cm  |
|  | mesh size in cod-end   | 35 mm  |
|  | bridle                 | 100 meters, 45 mm, 200 Kg/100m                                   |
|  | trawl doors            | polyvalent, 850 Kg   |
|  | vertical opening       | 3.5 m  |
|  | warp length            | 2 * Depth (m) + 250m   |
|  | warp diameter          | 20   |
|  | dan leno bobbin        | used   |
| Type of survey                                 |                        | Stratified sampling  |
| Station selection procedure                    |                        | Random   |
| Criterion to change position of a selected tow | -                      | unsuitable bottom for trawling according to ecosounder register. |
|  | -                      | Information on gear damage from previous surveys.                |
| Criterion to reject data from tow              | -                      | tears in cod-end   |
|  | -                      | severe tears in the gear   |
|  | -                      | less than 20 minutes tow   |
|  | -                      | bad behaviour of the gear  |
| Daily period for fishing                       |                        | 6.30 to 18:30 hours  |
| Species for sampling                           |                        | All fish, squid and shrimp                                       |

**Table 2.** Different indexes of shrimp estimated by swept area method in the years 1988-2020 on EU Flemish Cap surveys. From 1988-2002 the data were transformed by Warren method.

| Year              | Mean catch<br>per tow<br>(kg) | Total Biomass<br>(tons) | Biomass<br>CL>20mm<br>(tons) | Female Biomass<br>(tons) | Female Mean<br>catch per tow<br>(kg) |
|-------------------|-------------------------------|-------------------------|------------------------------|--------------------------|--------------------------------------|
| 1988              | 6.98                          | 5615                    | 5255                         | 4525                     | 5.63                                 |
| 1989              | 2.80                          | 2252                    | 2082                         | 1359                     | 1.69                                 |
| 1990              | 4.23                          | 3405                    | 2756                         | 1363                     | 1.69                                 |
| 1991              | 14.12                         | 11352                   | 10306                        | 6365                     | 7.91                                 |
| 1992              | 30.48                         | 24508                   | 23214                        | 15472                    | 19.24                                |
| 1993              | 14.52                         | 11673                   | 8596                         | 6923                     | 8.61                                 |
| 1994 <sup>1</sup> | 4.82                          | 3879                    | 3702                         | 2945                     | 3.66                                 |
| 1995              | 9.05                          | 7276                    | 6379                         | 4857                     | 6.04                                 |
| 1996              | 13.01                         | 10461                   | 8083                         | 5132                     | 6.38                                 |
| 1997              | 9.26                          | 7449                    | 6344                         | 4885                     | 6.07                                 |
| 1998 <sup>2</sup> | 48.95                         | 39367                   | 15562                        | 11444                    | 14.23                                |
| 1999              | 30.70                         | 24692                   | 15073                        | 13669                    | 17.00                                |
| 2000              | 23.63                         | 19003                   | 10649                        | 10172                    | 12.65                                |
| 2001              | 33.83                         | 27204                   | 17462                        | 13336                    | 16.58                                |
| 2002              | 45.40                         | 36510                   | 17319                        | 17091                    | 21.25                                |
| 2003              | 26.22                         | 21087                   | 13070                        | 11589                    | 14.41                                |
| 2004              | 25.10                         | 20182                   | 12027                        | 12081                    | 15.02                                |
| 2005              | 38.14                         | 30675                   | 13609                        | 14381                    | 17.88                                |
| 2006              | 20.19                         | 16235                   | 8578                         | 11477                    | 14.27                                |
| 2007              | 21.20                         | 17046                   | 11632                        | 12843                    | 15.97                                |
| 2008              | 13.79                         | 11092                   | 7857                         | 8630                     | 10.73                                |
| 2009              | 3.48                          | 2797                    | 1782                         | 1764                     | 2.19                                 |
| 2010              | 6.09                          | 4894                    | 4171                         | 3818                     | 4.31                                 |
| 2011              | 2.02                          | 1621                    | 1322                         | 1132                     | 1.39                                 |
| 2012              | 1.31                          | 1055                    | 795                          | 791                      | 0.98                                 |
| 2013              | 1.05                          | 844                     | 714                          | 691                      | 0.86                                 |
| 2014              | 1.12                          | 900                     | 757                          | 717                      | 0.89                                 |
| 2015              | 1.93                          | 1551                    | 1068                         | 1079                     | 1.34                                 |
| 2016              | 3.08                          | 2520                    | 1994                         | 1982                     | 2.46                                 |
| 2017              | 3.54                          | 2885                    | 2208                         | 2304                     | 2.86                                 |
| 2018              | 5.31                          | 4394                    | 3628                         | 4051                     | 4.90                                 |
| 2019              | 11.53                         | 9273                    | 7753                         | 8486                     | 10.6                                 |
| 2020              | 8.37                          | 6734                    | 5444                         | 6048                     | 7.52                                 |

<sup>1</sup> codend mesh-size 40 mm

<sup>2</sup> codend mesh-size 25 mm liner



**Table 3.** Total shrimp biomass by strata (tons) and percentage (%) of biomass in depths lesser than 140 ftm. estimated in EU Flemish Cap surveys. Between 1988 and 2002 data were transformed by Warren's method.

| Stratum | Depth<br>(Fathoms) | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|---------|--------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1       | 70-80              |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      | 3    |      |
| 2       | 81-100             |      |      |      |      |      |      |      |      |      |      | 175  |      |      | 69   | 112  | 690  | 217  |
| 3       | 101-140            |      |      |      | 10   |      |      |      |      | 148  | 39   | 639  | 450  | 1486 | 2169 | 5527 | 1817 | 2107 |
| 4       | 101-140            |      |      |      |      |      |      |      |      |      |      | 239  | 596  | 306  | 1099 | 1942 | 637  | 785  |
| 5       | 101-140            |      |      |      |      | 8    |      |      |      | 26   | 110  | 1107 | 1948 | 2135 | 2782 | 2445 | 3780 | 867  |
| 6       | 101-140            |      |      |      | 32   | 2    | 5    |      | 20   | 422  | 161  | 2915 | 1142 | 657  | 2112 | 2951 | 1667 | 1250 |
| 7       | 141-200            |      | 30   | 400  | 1265 | 3763 | 2704 | 117  | 506  | 1336 | 988  | 4056 | 3072 | 2213 | 3006 | 4632 | 1521 | 3108 |
| 8       | 141-200            |      |      | 88   | 248  | 1662 | 826  | 4    | 248  | 676  | 393  | 2402 | 2507 | 1140 | 2900 | 4257 | 1110 | 2043 |
| 9       | 141-200            | 133  | 69   | 35   |      |      | 135  |      | 613  | 459  | 412  | 3981 | 1139 | 1110 | 1483 | 1754 | 819  | 673  |
| 10      | 141-200            | 275  | 75   | 321  | 2103 | 3235 | 1778 | 752  | 1315 | 1148 | 1099 | 7186 | 4052 | 2771 | 3760 | 3748 | 4685 | 2489 |
| 11      | 141-200            | 263  |      | 148  | 1144 | 4096 | 1335 | 447  | 650  | 1235 | 1018 | 6049 | 3017 | 3005 | 4091 | 3460 | 3003 | 2350 |
| 12      | 201-300            | 2170 | 505  | 512  | 2361 | 4654 | 2115 | 636  | 1201 | 1295 | 1195 | 2042 | 2127 | 1082 | 845  | 1468 | 378  | 1222 |
| 13      | 201-300            |      | 66   | 64   | 89   | 38   | 136  |      | 28   | 687  | 554  | 1580 | 1465 | 43   | 620  | 217  | 23   | 230  |
| 14      | 201-300            | 618  | 375  | 623  | 995  | 2543 |      | 679  | 792  | 1076 | 426  | 3034 | 1717 | 689  | 843  | 2014 | 303  | 726  |
| 15      | 201-300            | 963  | 451  | 855  | 2004 | 3605 | 2292 | 1078 | 1370 | 1278 | 478  | 2575 | 1156 | 1753 | 837  | 1108 | 483  | 993  |
| 16      | 301-400            | 777  | 253  | 355  | 179  | 420  | 139  | 49   | 57   | 237  | 168  | 515  | 172  | 464  | 375  | 506  | 92   | 696  |
| 17      | 301-400            |      |      |      |      |      | 35   |      |      |      |      |      |      |      |      | 3    |      |      |
| 18      | 301-400            |      |      |      |      |      | 175  |      |      | 43   | 9    |      |      | 6    |      | 44   |      | 42   |
| 19      | 301-400            | 134  | 359  |      | 792  | 388  |      | 118  | 467  | 397  | 404  | 887  | 109  | 121  | 229  | 311  | 61   | 366  |
| 20      | 401-500            |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      | 6    |
| 21      | 501-600            |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 24      | 401-500            |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 25      | 501-600            |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 28      | 401-500            |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 29      | 501-600            |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      | 52   |
| 30      | 601-700            |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 31      | 601-700            |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 32      | 501-600            |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 33      | 401-500            |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| 34      | 501-600            |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |
| %       | <140 ftm.          | 0.0  | 0.0  | 0.0  | 0.4  | 0.0  | 0.0  | 0.0  | 0.3  | 5.7  | 4.2  | 12.9 | 16.8 | 24.2 | 30.2 | 35.6 | 40.8 | 25.8 |

<sup>1</sup>codend mesh-size 40 mm

<sup>2</sup>codend mesh-size 25 mm liner

Table 3. cont.

| Stratum | Depth<br>(Fathoms) | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|---------|--------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1       | 70-80              |      |      |      |      |      |      |      | 198  |      |      |      |      | 0    | 1    |      |      |
| 2       | 81-100             | 193  | 8    | 50   |      |      | 1    | 0    | 0    | 0    |      | 0    |      | 1    | 0    | 0    | 1    |
| 3       | 101-140            | 1207 | 477  | 20   | 11   | 1    | 21   | 1    | 0    | 5    | 0    | 1    | 12   | 14   | 13   | 51   | 2    |
| 4       | 101-140            | 2739 | 1195 | 11   | 1    | 3    | 15   | 0    | 1    | 0    | 1    | 0    | 1    | 4    | 6    | 0    | 0    |
| 5       | 101-140            | 847  | 664  | 558  | 11   | 28   | 21   | 1    | 8    | 5    | 2    | 1    | 5    | 23   | 24   | 116  | 3    |
| 6       | 101-140            | 1080 | 299  | 462  | 23   | 1    | 43   | 0    | 3    | 7    | 1    | 3    | 18   | 19   | 30   | 14   | 13   |
| 7       | 141-200            | 3202 | 1370 | 1642 | 468  | 32   | 495  | 8    | 46   | 81   | 29   | 74   | 277  | 635  | 245  | 366  | 76   |
| 8       | 141-200            | 5747 | 3084 | 709  | 1938 | 308  | 326  | 6    | 31   | 56   | 17   | 65   | 364  | 206  | 261  | 444  | 262  |
| 9       | 141-200            | 808  | 1435 | 1277 | 1159 | 48   | 235  | 31   | 21   | 32   | 10   | 36   | 32   | 137  | 122  | 386  | 266  |
| 10      | 141-200            | 2935 | 614  | 3248 | 671  | 154  | 467  | 58   | 31   | 36   | 25   | 223  | 246  | 428  | 359  | 968  | 315  |
| 11      | 141-200            | 2728 | 1086 | 2878 | 368  | 174  | 712  | 16   | 64   | 48   | 73   | 124  | 113  | 358  | 478  | 639  | 271  |
| 12      | 201-300            | 1980 | 1524 | 1965 | 1585 | 569  | 1060 | 242  | 208  | 204  | 263  | 219  | 649  | 488  | 857  | 1729 | 1208 |
| 13      | 201-300            | 903  | 691  | 373  | 1080 | 149  | 80   | 56   | 67   | 92   | 152  | 378  | 275  | 122  | 376  | 709  | 317  |
| 14      | 201-300            | 2750 | 923  | 1481 | 1593 | 215  | 305  | 460  | 79   | 118  | 141  | 150  | 158  | 110  | 308  | 825  | 900  |
| 15      | 201-300            | 1374 | 1539 | 1597 | 1944 | 649  | 824  | 407  | 133  | 101  | 113  | 177  | 257  | 243  | 1027 | 2197 | 2319 |
| 16      | 301-400            | 1587 | 840  | 526  | 108  | 145  | 188  | 208  | 115  | 34   | 37   | 60   | 30   | 59   | 69   | 531  | 374  |
| 17      | 301-400            | 10   | 196  | 56   | 33   | 2    |      | 8    | 0    | 0    |      | 1    | 33   | 2    | 10   | 0    | 39   |
| 18      | 301-400            | 56   | 115  | 8    | 10   | 3    | 20   | 9    | 0    | 0    |      | 0    |      | 0    |      |      | 1    |
| 19      | 301-400            | 530  | 173  | 187  | 61   | 278  | 77   | 172  | 35   | 25   | 36   | 16   | 8    | 35   | 209  | 298  | 367  |
| 20      | 401-500            | 353  | 29   | 20   | 5    | 1    | 0    | 39   | 0    |      | 0    |      | 0    |      |      |      | 51   |
| 21      | 501-600            | 2    |      |      |      |      |      | 0    |      | 0    | 0    |      |      |      |      |      |      |
| 22      | 501-600            |      |      |      |      |      |      |      |      |      |      |      |      | 1    |      |      |      |
| 24      | 401-500            |      |      |      |      |      |      | 0    |      |      |      |      |      | 0    |      | 3    | 11   |
| 25      | 501-600            |      |      |      |      |      |      |      | 0    |      |      |      |      |      |      |      |      |
| 28      | 401-500            | 138  | 175  | 54   | 71   | 26   |      | 11   | 7    | 11   | 0    |      |      | 11   | 10   | 49   | 73   |
| 29      | 501-600            |      |      |      |      |      | 1    |      |      |      | 0    |      |      |      |      |      | 0    |
| 30      | 601-700            |      |      |      |      |      | 0    |      |      | 0    | 0    |      | 0    |      |      | 0    |      |
| 31      | 601-700            |      |      |      |      |      |      |      | 0    |      |      |      |      |      |      |      |      |
| 32      | 501-600            |      |      |      |      |      | 0    |      |      |      |      |      |      |      |      |      |      |
| 33      | 401-500            | 6    |      |      |      | 7    |      |      |      | 0    |      | 0    |      |      |      |      |      |
| 34      | 501-600            | 12   |      |      | 1    |      | 0    |      | 0    |      |      |      | 0    |      | 0    | 0    | 1    |
| %       | <140 fth.          | 19.5 | 16.1 | 6.4  | 0.4  | 1.2  | 2.1  | 0.1  | 20.1 | 2.0  | 0.4  | 0.3  | 1.4  | 2.1  | 1.7  | 1.9  | 0.3  |

**Table 4.** Shrimp length frequencies ( $\times 10^4$ ) and percentages by sex and maturity stage from EU Flemish Cap 2020.

| LENGTH<br>(mm CL) | MALES | FEMALES     |             |           |
|-------------------|-------|-------------|-------------|-----------|
|                   |       | Primiparous | Multiparous | Ovigerous |
| 8.5               |       |             |             |           |
| 9                 |       |             |             |           |
| 9.5               |       |             |             |           |
| 10                | 1     |             |             |           |
| 10.5              | 24    |             |             |           |
| 11                | 16    |             |             |           |
| 11.5              | 71    |             |             |           |
| 12                | 219   |             |             |           |
| 12.5              | 356   | 46          |             |           |
| 13                | 743   | 20          |             |           |
| 13.5              | 1471  | 31          |             |           |
| 14                | 2059  | 58          |             |           |
| 14.5              | 2456  | 98          |             |           |
| 15                | 2016  | 99          |             |           |
| 15.5              | 1519  | 98          | 28          |           |
| 16                | 1284  | 143         |             |           |
| 16.5              | 1010  | 134         | 5           |           |
| 17                | 1028  | 386         |             |           |
| 17.5              | 1477  | 1029        |             |           |
| 18                | 2387  | 1817        | 9           |           |
| 18.5              | 1909  | 2801        | 26          |           |
| 19                | 1737  | 3238        | 47          | 45        |
| 19.5              | 790   | 3113        | 60          |           |
| 20                | 592   | 3372        | 207         |           |
| 20.5              | 179   | 3421        | 455         |           |
| 21                | 117   | 3296        | 920         |           |
| 21.5              | 87    | 4205        | 2047        |           |
| 22                | 103   | 5300        | 2529        |           |
| 22.5              | 125   | 6143        | 2720        |           |
| 23                | 112   | 6188        | 3068        |           |
| 23.5              |       | 6458        | 3433        |           |
| 24                | 9     | 4173        | 2829        |           |
| 24.5              |       | 2729        | 2688        |           |
| 25                |       | 1617        | 2207        |           |
| 25.5              | 5     | 867         | 1982        |           |
| 26                |       | 442         | 1324        | 2         |
| 26.5              |       | 361         | 802         |           |
| 27                |       | 180         | 746         |           |
| 27.5              |       | 38          | 565         |           |
| 28                |       | 33          | 244         |           |
| 28.5              |       | 5           | 53          |           |
| 29                |       | 1           | 33          |           |
| 29.5              |       |             | 2           |           |
| 30                |       |             | 2           |           |
| 30.5              |       |             | 2           |           |
| 31                | 1     |             |             |           |
| 31.5              | 24    |             |             |           |
| 32                |       |             |             |           |
| Total             | 23902 | 61940       | 29035       | 47        |
| Percentage %      | 20.8% | 53.9%       | 25.3%       | 0.0%      |

**Table 5.** Males percentage as total biomass of northern shrimp from EU Flemish Cap 1988 - 2020 surveys.

| Year         | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 <sup>1</sup> | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 |
|--------------|------|------|------|------|------|------|------|------|------|------|-------------------|------|------|------|------|------|------|
| Males (%)    | 6.4  | 7.5  | 19.1 | 9.2  | 5.3  | 26.4 | 4.6  | 12.3 | 22.7 | 14.8 | 60.5              | 39.0 | 44.0 | 35.8 | 52.6 | 38.0 | 40.4 |
| <20mm CL (%) | 19.4 | 39.7 | 60.0 | 43.9 | 36.9 | 40.7 | 24.1 | 33.2 | 50.9 | 34.4 | 70.9              | 44.6 | 46.5 | 51.0 | 53.2 | 45.0 | 40.1 |

| Year         | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|--------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Males (%)    | 55.6 | 47.2 | 31.8 | 29.2 | 36.3 | 14.8 | 24.9 | 30.4 | 15.4 | 15.9 | 31.1 | 20.9 | 20.1 | 7.8  | 8.5  | 10.2 |
| <20mm CL (%) | 53.1 | 29.3 | 24.7 | 22.2 | 36.9 | 22.0 | 28.9 | 25.0 | 18.1 | 20.3 | 30.4 | 21.3 | 20.1 | 17.4 | 16.4 | 19.2 |

<sup>1</sup> codend mesh-size 25 mm liner**Table 6.** Shrimp length frequencies ( $\times 10^3$ ) estimated from the small mesh size bag attached to the cod-end in 2020 survey.

| Length (CL)<br>mm | Frequency | Length (CL)<br>mm | Frequency |
|-------------------|-----------|-------------------|-----------|
| 5.5               | 27        | 17                | 161       |
| 6                 | 171       | 17.5              | 119       |
| 6.5               | 534       | 18                | 127       |
| 7                 | 1036      | 18.5              | 201       |
| 7.5               | 1405      | 19                | 154       |
| 8                 | 1158      | 19.5              | 57        |
| 8.5               | 723       | 20                | 112       |
| 9                 | 364       | 20.5              | 16        |
| 9.5               | 201       | 21                | 75        |
| 10                | 107       | 21.5              | 9         |
| 10.5              | 181       | 22                | 9         |
| 11                | 355       | 22.5              | 23        |
| 11.5              | 1101      | 23                | 0         |
| 12                | 2072      | 23.5              | 0         |
| 12.5              | 3464      | 24                | 0         |
| 13                | 4091      | 24.5              | 23        |
| 13.5              | 4121      | 25                | 0         |
| 14                | 3787      | 25.5              | 0         |
| 14.5              | 2629      | 26                | 0         |
| 15                | 1449      | 26.5              | 0         |
| 15.5              | 807       | 27                | 11        |
| 16                | 403       |                   |           |
| 16.5              | 153       | Total             | 31436     |
| Biomass           |           | 45 t              |           |

**Table 7.** Shrimp modal groups by sexes and ages with Lofoten gear and bag in the codend in 2020 from EU Flemish Cap survey interpreted from size distributions.

| LOFOTEN |              |         |        |
|---------|--------------|---------|--------|
| Age     | Modal groups |         | Cohort |
|         | Males        | Females |        |
| 1       |              | -       | H      |
| 2       | 14.5         | -       | G      |
| 3       | 18.5         | 19.5    | F      |
| 4       | -            | 23.0    | E      |
| 5       | -            | 25.0    | D      |
| 6       | -            | 26.5    | C      |
| 7       | -            | 28.0    | B      |

| BAG ON THE CODEND |              |  |        |
|-------------------|--------------|--|--------|
| Age               | Modal groups |  | Cohort |
|                   |              |  |        |
| 1                 | 8            |  | H      |
| 2                 | 14           |  | G      |
| 3                 |              |  |        |

**Table 8.** Results of the modal analysis (MIX) by sex and maturity stage from EU Flemish Cap surveys 2020 with Lofoten gear and juvenile bag.

| Sex and Maturity | Juvenile bag (6mm) |          | Lofoten gear (35 mm.) |          |                     |          |                     |          |
|------------------|--------------------|----------|-----------------------|----------|---------------------|----------|---------------------|----------|
|                  |                    |          | Males                 |          | Primiparous females |          | Multiparous females |          |
| Age              | Prop.              | St. Dev. | Prop.                 | St. Dev. | Prop.               | St. Dev. | Prop.               | St. Dev. |
| 1                | 0.183              | 0.0022   |                       |          |                     |          |                     |          |
| 2                | 0.783              | 0.0025   | 0.5760                | 0.0046   | 0.0083              |          |                     |          |
| 3                | 0.034              | 0.0013   | 0.4033                | 0.0049   | 0.2493              |          | 0.0151              |          |
| 4                |                    |          | 0.0207                | 0.0014   | 0.6559              |          | 0.5224              |          |
| 5                |                    |          |                       |          | 0.0864              |          | 0.4106              |          |
| 6                |                    |          |                       |          | 0.0000              |          | 0.0519              |          |
| 7                |                    |          |                       |          |                     |          | 0.0000              |          |
| Age              |                    |          | Media CL              | St. Dev. | Media CL            | St. Dev. | Media CL            | St. Dev. |
| 1                | 7.96               | 0.0131   |                       |          | 15.01               |          |                     |          |
| 2                | 13.65              | 0.0080   | 14.97                 | 0.0179   |                     |          |                     |          |
| 3                | 18.90              | 0.0752   | 18.65                 | 0.0137   | 19.50               |          | 20.34               |          |
| 4                |                    |          | 22.4                  | 0.0760   | 22.51               |          | 22.84               |          |
| 5                |                    |          |                       |          | 24.99               |          | 25.18               |          |
| 6                |                    |          |                       |          | 27.00               |          | 26.78               |          |
| 7                |                    |          |                       |          |                     |          | 27.55               |          |
| Age              |                    |          | Sigma                 | St. Dev. | Sigma               | St. Dev. | Sigma               | St. Dev. |
| 1                | 0.875              | 0.0113   |                       |          |                     |          |                     |          |
| 2                | 1.134              | 0.0070   | 1.2636                | 0.0138   | 0.9642              | CCV      |                     | FCV      |
| 3                | 1.546              | 0.0537   | 0.9069                | 0.0135   | 1.2526              | CCV      | 0.9151              | FCV      |
| 4                |                    |          | 0.8656                | 0.0732   | 1.4465              | CCV      | 1.0277              | FCV      |
| 5                |                    |          |                       |          | 1.6054              | CCV      | 1.1330              | FCV      |
| 6                |                    |          |                       |          | 1.7346              | CCV      | 1.2052              | FCV      |
| 7                |                    |          |                       |          |                     |          | 1.2395              | FCV      |

**Table 9.** Mean length (mm.) at age by years in EU Flemish Cap surveys

| Year<br>Age-class | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|-------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1                 |      |      |      |      |      |      |      |      |      |      | 10.3 | 8.5  | 10.3 | 10.5 | 10.2 | 9.3  |      |      |      |      |      |      | 11.7 |      | 12.4 |      | 12.1 |      |      |      | 9.9  |      |      |
| 2                 |      |      |      |      |      |      |      |      | 14.4 | 15.7 | 14.2 | 14.4 | 14.4 | 14.2 | 15.1 | 15.5 | 14.4 | 12.9 | 12.6 | 12.5 | 13.4 | 15.9 | 17.6 | 16.7 | 16.1 | 17.2 |      | 16.8 | 16.3 | 16.2 | 16.5 | 15.8 | 15.0 |
| 3                 | 18.2 | 15.4 |      | 18.0 | 18.2 | 15.8 | 17.4 | 16.8 | 20.6 | 19.7 | 18.9 | 17.7 | 18.3 | 16.5 | 18.3 | 19.5 | 19.0 | 16.6 | 15.7 | 15.3 | 17.7 | 18.2 | 20.8 | 20.6 | 20.1 | 19.4 | 18.1 | 20.4 | 19.7 | 20.1 | 20.3 | 20.8 | 19.2 |
| 4                 | 20.3 | 20.4 | 20.8 | 20.0 | 19.7 | 20.4 | 21.6 | 21.5 | 22.6 | 23.0 | 21.8 | 21.7 | 20.4 | 20.4 | 21.7 | 21.1 | 22.2 | 19.9 | 18.1 | 18.9 | 21.0 | 20.7 | 23.3 | 22.6 | 23.6 | 21.8 | 22.6 | 22.5 | 21.7 | 23.4 | 22.6 | 23.7 | 22.6 |
| 5                 | 26.3 | 24.2 | 25.9 | 24.4 | 24.0 | 24.2 | 24.8 | 23.0 | 25.3 | 24.8 | 23.5 | 23.8 | 22.7 | 23.1 | 23.7 | 23.3 | 24.1 | 21.9 | 20.7 | 20.6 | 23.4 | 23.0 | 24.4 | 24.5 | 25.0 | 23.9 | 24.4 | 25.4 | 24.3 | 26.8 | 24.9 | 26.5 | 25.1 |
| 6                 | 29.5 | 28.7 | 28.8 | 26.5 | 27.3 | 26.3 | 27.9 | 26.0 | 27.5 | 26.5 | 25.9 | 26.1 | 25.0 | 25.6 | 25.0 | 26.2 | 26.7 | 24.1 | 23.7 | 23.1 | 26.2 | 25.1 | 26.0 | 27.8 | 27.8 | 25.9 | 26.1 | 26.1 | 26.9 |      | 25.8 | 28.0 | 26.8 |
| 7                 | 32.2 | 31.7 | 32.1 | 29.6 | 29.2 | 28.3 | 30.3 | 28.4 | 29.6 | 29.3 | 29.0 | 28.7 | 27.4 | 29.1 | 27.4 | 28.7 | 28.0 | 26.4 | 26.3 | 25.2 |      | 27.4 |      |      |      |      |      |      |      |      | 28.2 | 29.5 | 27.6 |
| 8                 |      |      |      | 31.2 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      | 31.5 |
| 9                 |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      | 33.5 |
| 10                |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      | 35.0 |
| Total             | 26.4 | 25.2 | 22.5 | 24.9 | 26.2 | 21.4 | 25.3 | 23.0 | 21.5 | 23.1 | 18.1 | 20.1 | 20.5 | 20.1 | 19.6 | 20.2 | 18.9 | 18.5 | 19.8 | 20.2 | 20.9 | 20.0 | 21.6 | 21.2 | 21.2 | 22.1 | 22.4 | 20.6 | 21.4 | 21.8 | 22.1 | 22.5 | 21.7 |

<sup>1</sup>Codend mesh-size 40 mm.<sup>2</sup>Codend mesh-size 25 mm.**Table 10.** Abundance (10<sup>6</sup>) at age by years in EU Flemish Cap surveys.

| Age-class | 1988 | 1989 | 1990 | 1991 | 1992 | 1993 | 1994 <sup>1</sup> | 1995 | 1996 | 1997 | 1998 <sup>2</sup> | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |
|-----------|------|------|------|------|------|------|-------------------|------|------|------|-------------------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1         |      |      |      |      |      |      |                   |      |      |      | 94                | 1    | 9    | 3    | 181  | 14   |      |      |      |      |      |      | 8    |      |      | 1    |      |      | 0    |      |      | 1    |      |
| 2         |      |      |      |      |      |      |                   |      | 342  | 63   | 5497              | 474  | 107  | 332  | 1100 | 1257 | 2742 | 179  | 58   | 30   | 22   | 118  | 111  | 60   | 23   | 6    |      | 111  | 23   | 69   | 91   | 103  | 145  |
| 3         | 13   | 1    |      | 47   | 159  | 788  | 43                | 243  | 857  | 289  | 4235              | 2392 | 1704 | 1877 | 4787 | 1774 | 960  | 6903 | 301  | 387  | 646  | 161  | 418  | 90   | 89   | 18   | 35   | 41   | 109  | 128  | 163  | 603  | 260  |
| 4         | 123  | 82   | 404  | 260  | 146  | 376  | 88                | 276  | 153  | 241  | 707               | 1496 | 1074 | 2015 | 1128 | 548  | 643  | 524  | 1949 | 1221 | 857  | 169  | 275  | 109  | 56   | 60   | 43   | 93   | 214  | 245  | 191  | 554  | 572  |
| 5         | 233  | 81   | 92   | 465  | 440  | 205  | 73                | 120  | 273  | 322  | 789               | 601  | 572  | 1184 | 1047 | 907  | 783  | 1050 | 1205 | 1276 | 575  | 91   | 24   | 31   | 11   | 40   | 42   | 17   | 49   | 11   | 132  | 147  | 175  |
| 6         | 163  | 83   | 33   | 389  | 1129 | 446  | 181               | 215  | 65   | 115  | 414               | 204  | 349  | 323  | 311  | 243  | 133  | 758  | 522  | 588  | 40   | 25   |      | 0    | 1    | 3    | 6    | 9    | 6    |      | 29   | 4    | 15   |
| 7         | 15   | 11   | 2    | 103  | 398  | 49   | 8                 | 122  | 44   | 16   | 15                | 8    | 61   | 16   | 55   | 9    | 21   | 141  | 65   | 129  |      | 7    |      |      |      |      |      |      |      |      | 5    | 2    | 0    |
| 8         |      |      |      | 33   |      |      |                   |      |      |      |                   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      | 1    |
| >8        |      |      |      |      |      |      |                   |      |      |      |                   |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      |      | 1    |
| Total     | 548  | 258  | 530  | 1296 | 2271 | 1864 | 391               | 976  | 1734 | 1046 | 11751             | 5177 | 3876 | 5750 | 8608 | 4753 | 5281 | 9554 | 4098 | 3631 | 2141 | 570  | 828  | 290  | 179  | 128  | 126  | 271  | 401  | 452  | 612  | 1416 | 1167 |

<sup>1</sup>Codend mesh-size 40 mm.<sup>2</sup>Codend mesh-size 25 mm.

**Table 11.** Biomass estimated (tons) at age by years in EU Flemish Cap surveys.

| Age-class | 1988 | 1989 | 1990 | 1991  | 1992  | 1993  | 1994 <sup>1</sup> | 1995 | 1996  | 1997 | 1998 <sup>2</sup> | 1999  | 2000  | 2001  | 2002  | 2003  | 2004  | 2005  | 2006  | 2007  | 2008  | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 |      |
|-----------|------|------|------|-------|-------|-------|-------------------|------|-------|------|-------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| 1         |      |      |      |       |       |       |                   |      |       |      | 60                | 1     | 6     | 2     | 114   | 6     |       |       |       |       |       |      | 9    |      |      | 1    |      |      | 0    |      |      | 1    |      |      |
| 2         |      |      |      |       |       |       |                   |      | 609   | 139  | 9039              | 832   | 183   | 572   | 2178  | 2541  | 4660  | 187   | 57    | 38    | 33    | 303  | 372  | 177  | 63   | 21   |      | 364  | 65   | 190  | 267  | 259  | 281  |      |
| 3         |      | 44   | 2    |       | 166   | 610   | 2144              | 145  | 685   | 4552 | 1270              | 16203 | 7811  | 5924  | 5018  | 16710 | 7134  | 3730  | 15782 | 586   | 837   | 2094 | 600  | 2029 | 461  | 450  | 85   | 141  | 243  | 535  | 651  | 903  | 3187 | 1044 |
| 4         |      | 575  | 387  | 2053  | 1214  | 705   | 2083              | 554  | 1658  | 1071 | 1705              | 4099  | 9016  | 5233  | 9992  | 6436  | 2762  | 3969  | 2109  | 5882  | 4764  | 4491 | 892  | 1690 | 726  | 431  | 379  | 316  | 678  | 1395 | 1920 | 1460 | 4206 | 3706 |
| 5         |      | 2377 | 626  | 888   | 3843  | 3683  | 1823              | 681  | 892   | 2703 | 2853              | 5719  | 4784  | 3838  | 8321  | 7758  | 6197  | 6206  | 5702  | 5547  | 6330  | 4084 | 635  | 644  | 250  | 104  | 323  | 379  | 181  | 450  | 124  | 1353 | 1496 | 1541 |
| 6         |      | 2334 | 1053 | 436   | 4094  | 13637 | 4948              | 2374 | 2313  | 827  | 1249              | 4038  | 2138  | 3112  | 3087  | 2696  | 2339  | 1430  | 5531  | 3606  | 3971  | 390  | 224  | 149  | 5    | 7    | 35   | 64   | 61   | 75   |      | 333  | 51   | 161  |
| 7         |      | 285  | 183  | 28    | 1478  | 5801  | 675               | 124  | 1728  | 700  | 234               | 207   | 112   | 706   | 215   | 616   | 108   | 254   | 1365  | 621   | 1105  |      | 81   |      |      |      |      |      |      |      | 79   | 29   | 0    |      |
| 8         |      |      |      |       | 557   |       |                   |      |       |      |                   |       |       |       |       |       |       |       |       |       |       |      |      |      |      |      |      |      |      |      |      | 13   |      |      |
| >8        |      |      |      |       |       |       |                   |      |       |      |                   |       |       |       |       |       |       |       |       |       |       |      |      |      |      |      |      |      |      |      |      | 31   |      |      |
| Total     | 5615 | 2252 | 3405 | 11352 | 24436 | 11673 | 3879              | 7276 | 10461 | 7449 | 39365             | 24695 | 19002 | 27206 | 36508 | 21087 | 20248 | 30675 | 16299 | 17045 | 11092 | 2735 | 4893 | 1619 | 1055 | 844  | 900  | 1527 | 2521 | 2885 | 4394 | 9273 | 6734 |      |

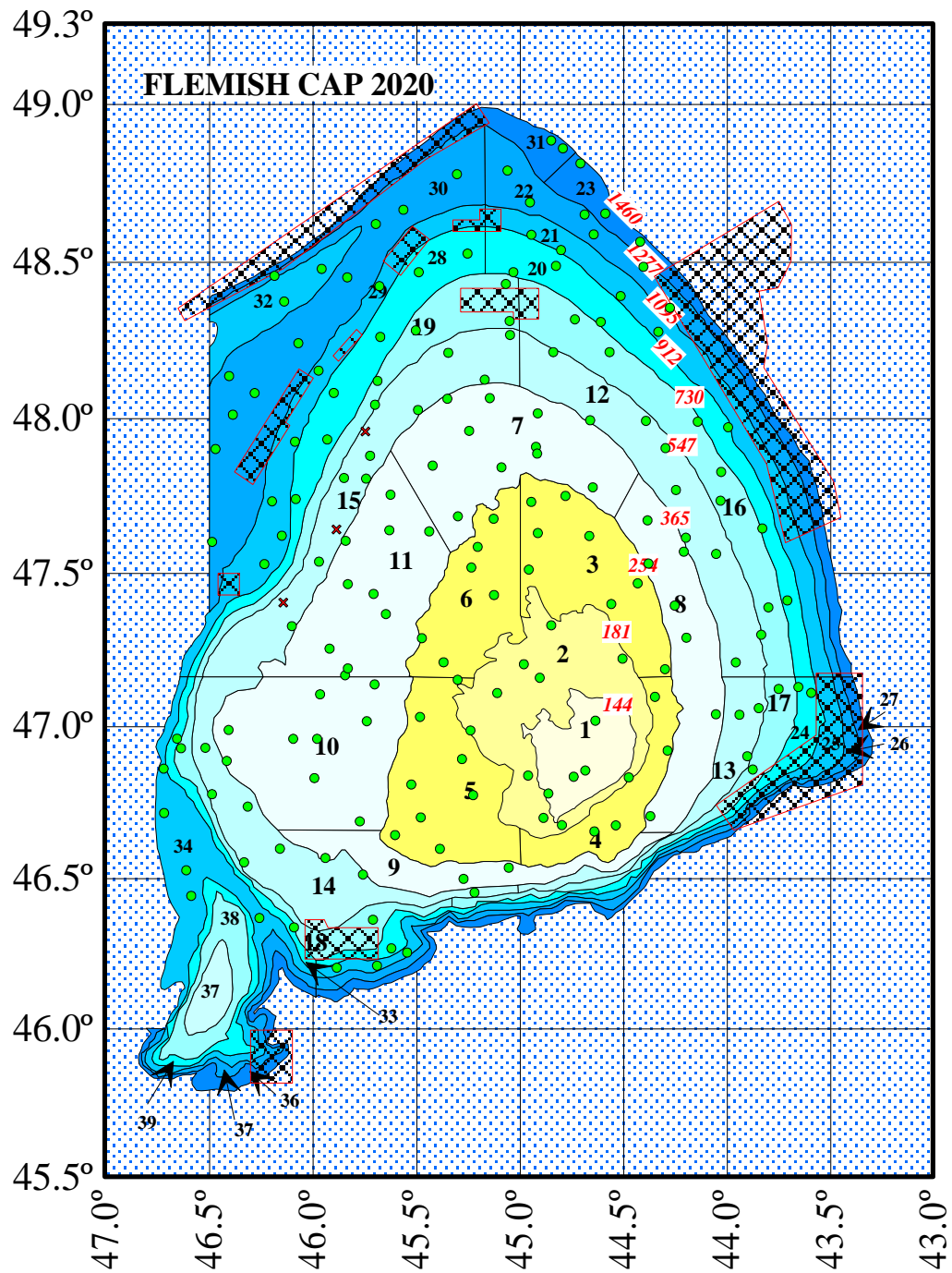
<sup>1</sup>Codend mesh-size 40 mm.<sup>2</sup>Codend mesh-size 25 mm.**Table 12.** Abundance at age 2 and average-weighted as indicator of recruitment (R) in the survey (lofoten gear) and from juvenile bag.

| year | R (age 2) juvbag<br>(‘000) | R (age 2) Lofoten<br>(‘00000) | R(2)juvbag<br>Av_weighted | R(2)lofoten<br>Av_weighted |
|------|----------------------------|-------------------------------|---------------------------|----------------------------|
| 2001 | 1361                       | 3711                          | 0.26                      | 1.08                       |
| 2002 | 2125                       | 11004                         | 0.41                      | 3.21                       |
| 2003 | 0                          | 13869                         | 0.00                      | 4.04                       |
| 2004 | 41818                      | 27415                         | 8.06                      | 7.99                       |
| 2005 | 3741                       | 1792                          | 0.72                      | 0.52                       |
| 2006 | 7498                       | 809                           | 1.45                      | 0.24                       |
| 2007 | 3824                       | 282                           | 0.74                      | 0.08                       |
| 2008 | 4969                       | 473                           | 0.96                      | 0.14                       |
| 2009 | 3011                       | 1514                          | 0.58                      | 0.44                       |
| 2010 | 954                        | 1106                          | 0.18                      | 0.32                       |
| 2011 | 2440                       | 611                           | 0.47                      | 0.18                       |
| 2012 | 160                        | 216                           | 0.03                      | 0.06                       |
| 2013 | 102                        | 63                            | 0.02                      | 0.02                       |
| 2014 | 56                         | 242                           | 0.01                      | 0.07                       |
| 2015 | 427                        | 1111                          | 0.08                      | 0.32                       |
| 2016 | 390                        | 230                           | 0.08                      | 0.07                       |
| 2017 | 1411                       | 676                           | 0.27                      | 0.20                       |
| 2018 | 552                        | 1048                          | 0.11                      | 0.31                       |
| 2019 | 3536                       | 1010                          | 0.68                      | 0.29                       |
| 2020 | 25332                      | 1440                          | 4.89                      | 0.42                       |

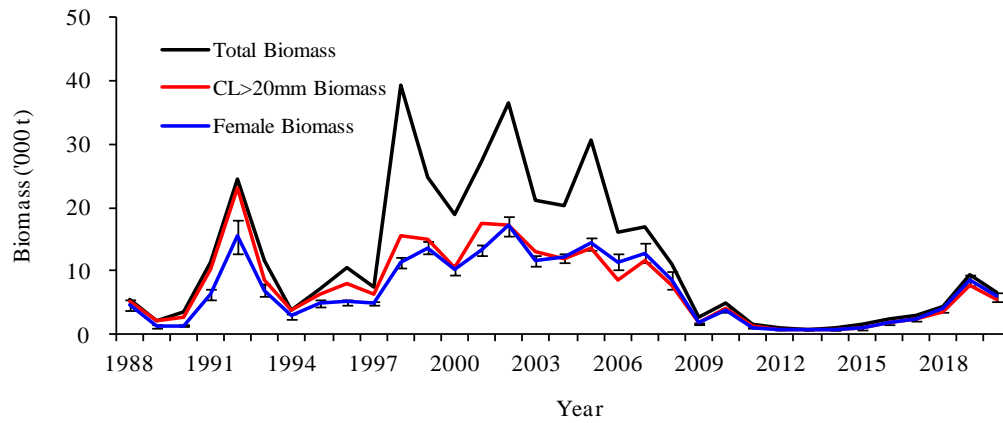
**Table 13.** Abundance at age 1 and average-weighted in the survey from juvenile bag.

| <b>year</b> | <b>R (age 1) juvbag<br/>(‘000)</b> | <b>R(age1)juvbag<br/>Av_weighted</b> |
|-------------|------------------------------------|--------------------------------------|
| 2001        | 380                                | 0.06                                 |
| 2002        | 6044                               | 0.90                                 |
| 2003        | 48165                              | 7.21                                 |
| 2004        | 2314                               | 0.35                                 |
| 2005        | 9515                               | 1.42                                 |
| 2006        | 953                                | 0.14                                 |
| 2007        | 5123                               | 0.77                                 |
| 2008        | 5916                               | 0.88                                 |
| 2009        | 1504                               | 0.22                                 |
| 2010        | 6102                               | 0.91                                 |
| 2011        | 1050                               | 0.16                                 |
| 2012        | 42                                 | 0.01                                 |
| 2013        | 195                                | 0.03                                 |
| 2014        | 239                                | 0.04                                 |
| 2015        | 61                                 | 0.01                                 |
| 2016        | 1592                               | 0.24                                 |
| 2017        | 6669                               | 1.00                                 |
| 2018        | 327                                | 0.05                                 |
| 2019        | 31594                              | 4.73                                 |
| 2020        | 5912                               | 0.88                                 |

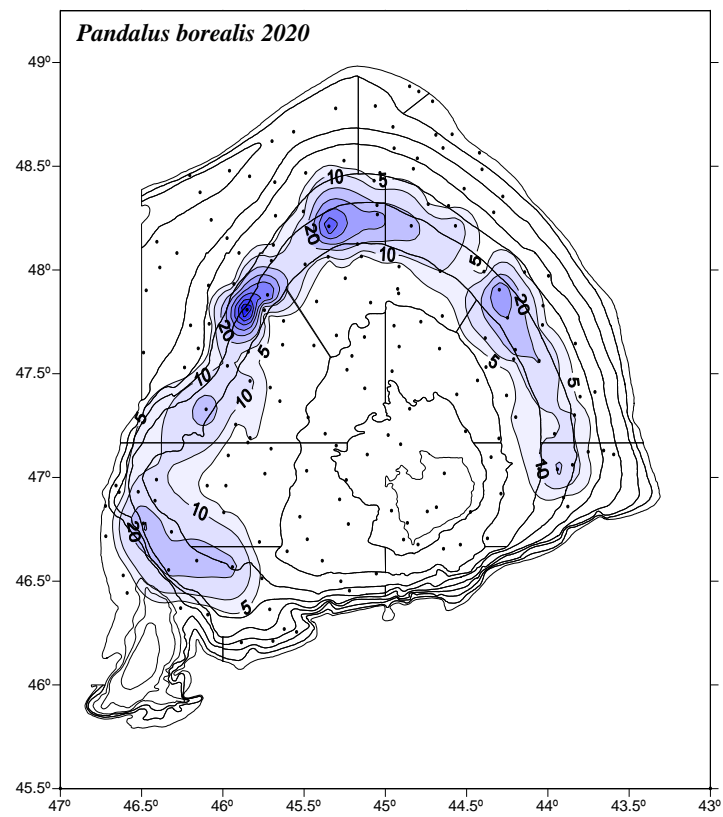




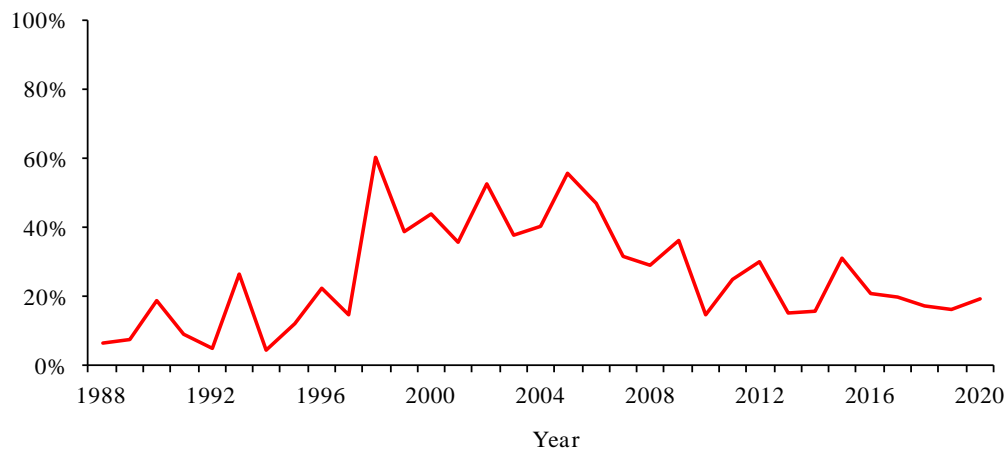
**Figure 1.** Chart with the positions of the hauls carried out in EU Flemish Cap survey 2020.



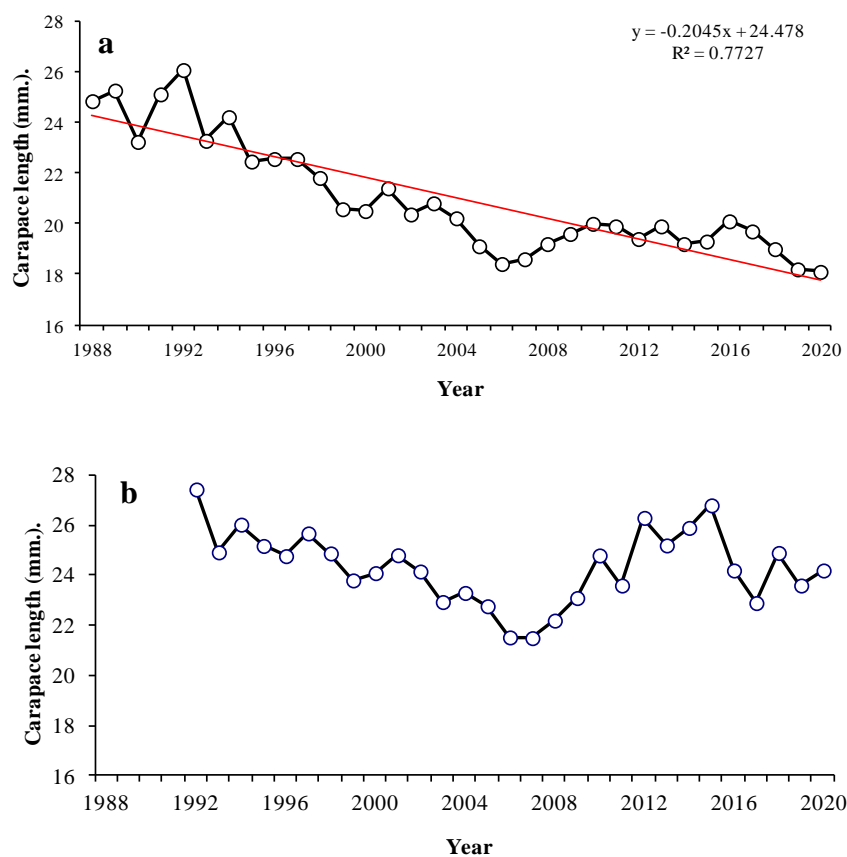
**Figure 2.** Total, female and adult biomass (shrimp bigger than 20 mm CL) from EU Flemish Cap 1988-2020 surveys.



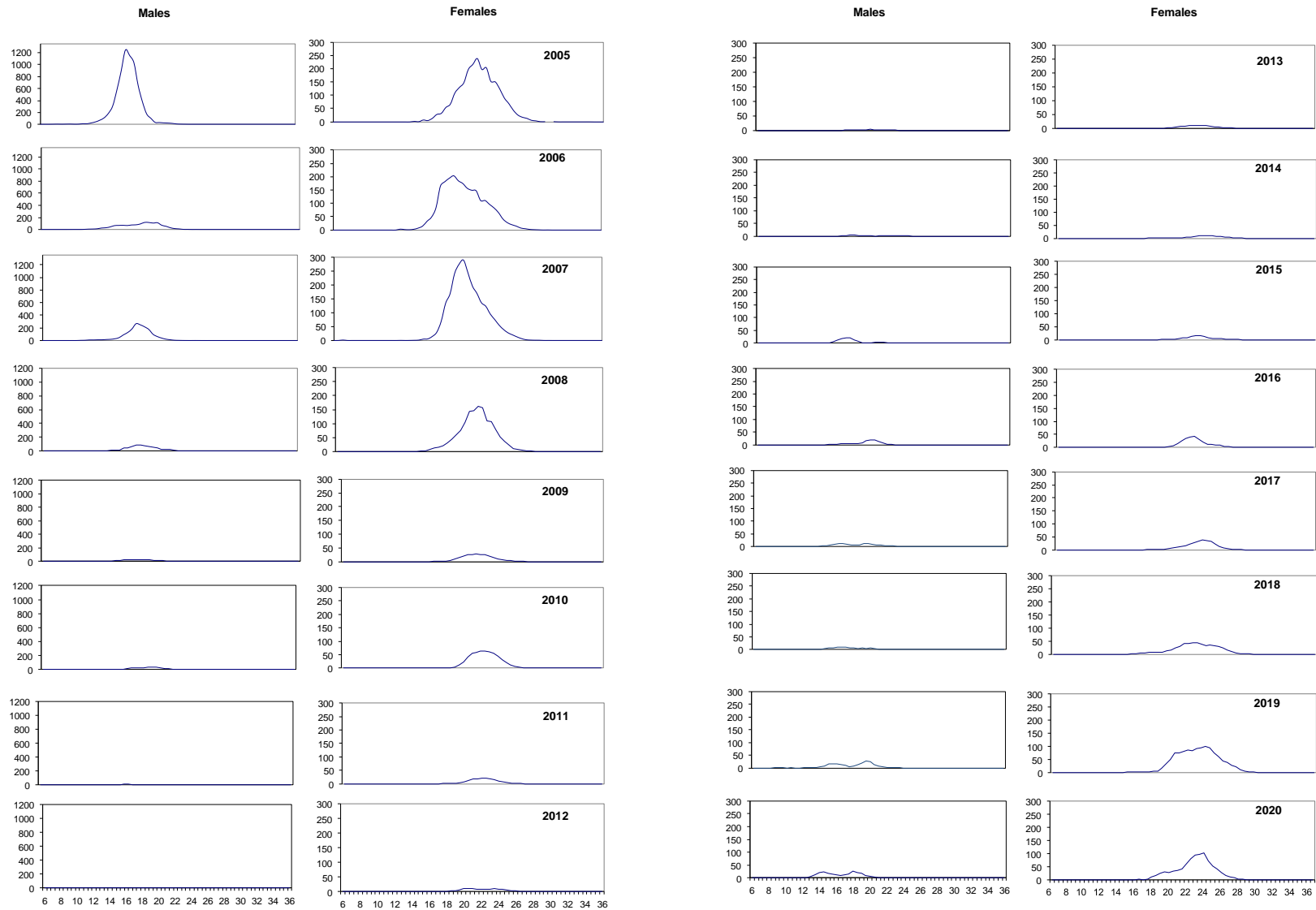
**Figure 3.** Shrimp catches distribution (kg/tow) from EU Flemish Cap survey in summer 2020.



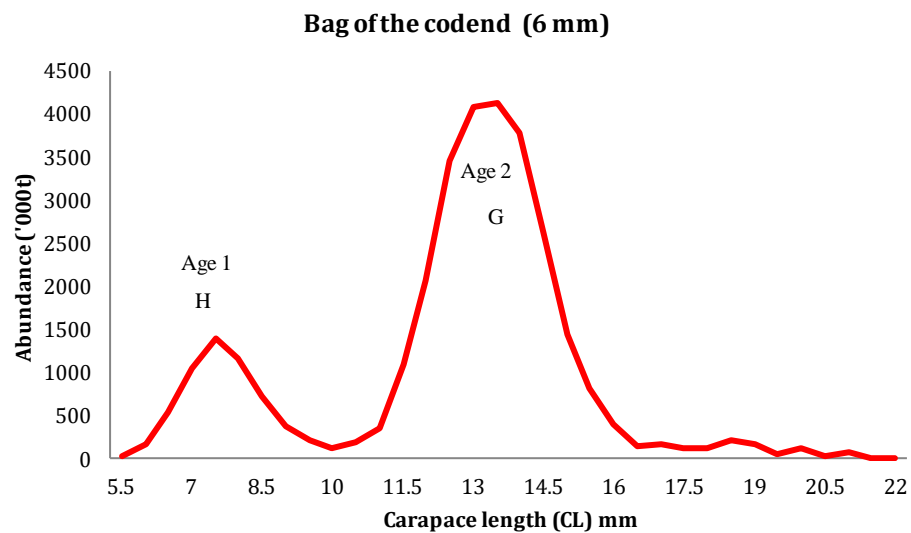
**Figure 4.** Differences between total biomass and adult biomass (>20 mm CL) as percentage of Total biomass from EU Flemish Cap 1988-2020 surveys.



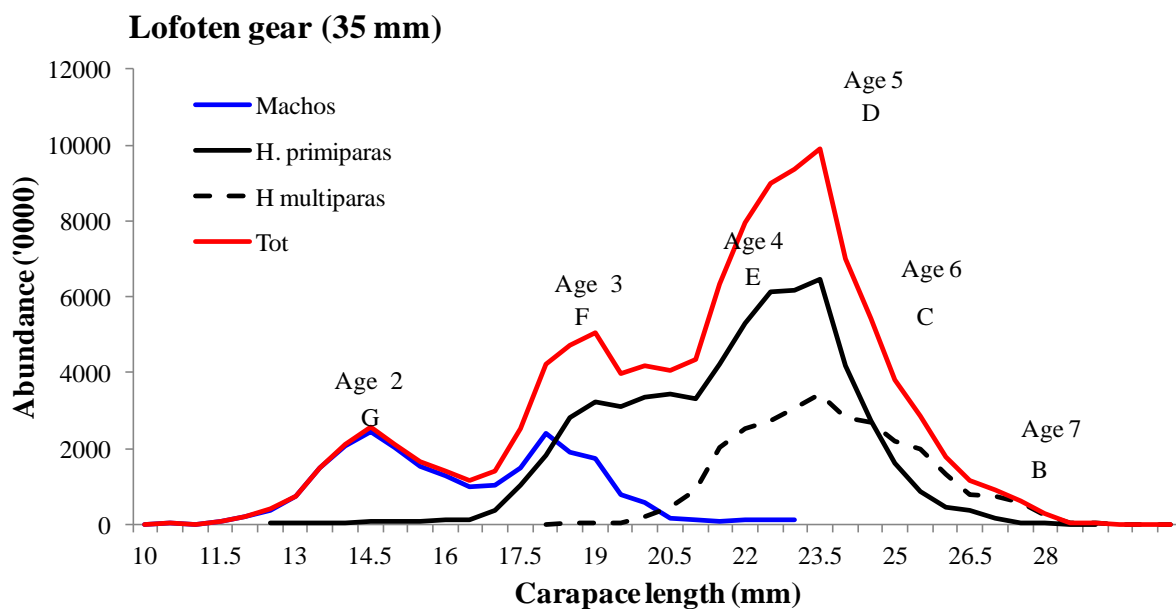
**Figure 5.** Lengths (CL) at sex change (a) and maturity (b) of shrimp in EU Flemish Cap surveys



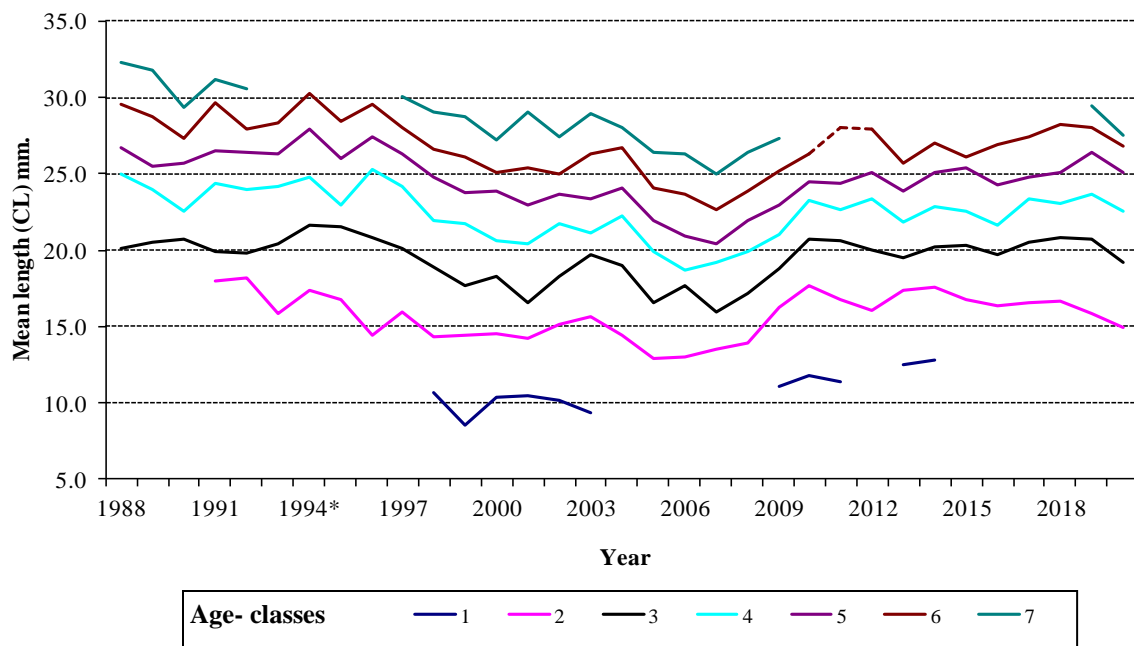
**Figure 6.** Shrimp size distribution from Flemish Cap 2006 -2020 surveys. Y-Axis=Frequency ( $10^6$ ), X-Axis=Carapace Length (mm).



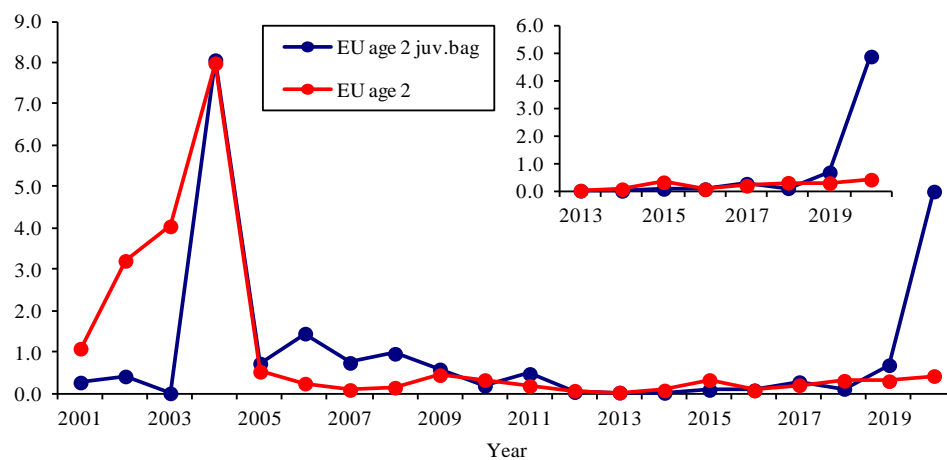
**Figure 7.** Shrimp modal and age groups in 2020 EU survey on Flemish Cap from juvenile bag. (letters from Table 7).



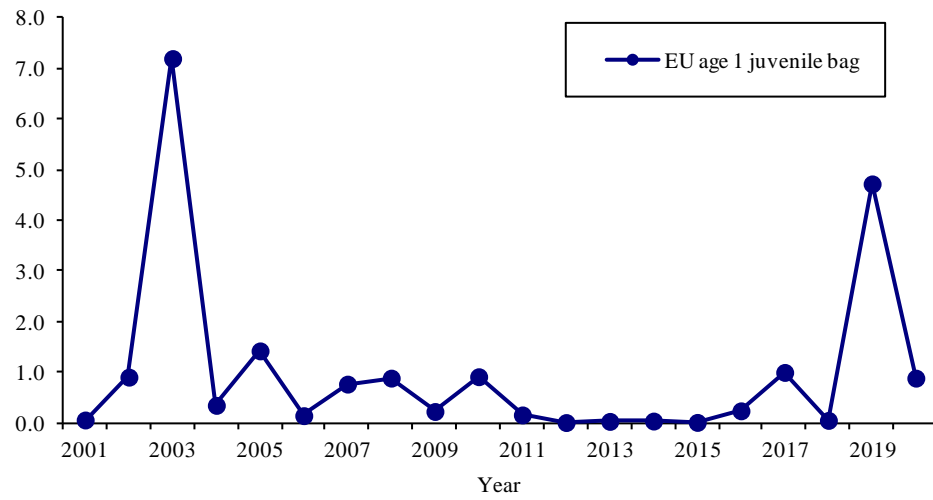
**Figure 8.** Shrimp modal and age groups in 2020 EU Flemish Cap survey (letters from table 7).



**Figure 9.** Shrimp mean lengths at age in the series of EU surveys on Flemish Cap.



**Figure 10.** Abundance indexes at age 2 (weighted-average) obtained in EU Flemish Cap surveys from Lofoten gear (red line) and Juvenile bag (blue line).



**Figure 11.** Abundance indexes at age 1 (weighted-average) obtained in EU Flemish Cap surveys from Juvenile bag .