French data processing for assessment working groups

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Introduction

During the flatfish benchmark held in ICES in 2020 (WKFlatNSCS), questions arose on the modifications made recently on two key fields of fisheries data processed by France for providing data to stock assessment groups. These two fields are:

- the gap filling method in Age Length Keys
- the effort aggregates in support of discards raising procedure

Updates of procedures, improvements of R scripts and coding are done permanently, and some of the modifications made in 2019 at the demand of WGNSSK experts had unraveled issues that went undetected until data submission of sol.27.7d full time series for WKFlatNSCS benchmark. These issues may have also impacted the Celtic Sea benchmark (WKCELTIC) and to a lesser extent the WKDEM earlier in the year. As a reminder, France provided information on more than 150 stocks to ICES in 2019, among which 106 and 27 with respectively length and age structures of landings and 28 with discards volume and length structures. A dedicated team (a.k.a CREDO team) has been built to process these data, and ensure the provision of data to all RFMO (e.g. ICCAT, GFCM, IOTC), STECF and all national and international instances asking for data for management purposes. In 2019, France provided data to more than 200 data calls. A quality procedure has been put in place, enabling the follow-up of all demands and data sent. Improvements of the procedure and method are already listed and on track, and with the issue raised in WKFlatNSCS, we understand that improvements and priorities will have to be reviewed. This document is meant to bring clarity in the procedure used recently, the differences it made on the final estimates of discards and age structures, and propose a way to fix the issues.

Filling Gaps in Age Length Keys

The empirical Age Length Keys (ALKs), i.e. pivot tables of observed age-at-length, are prone to both incomplete representation of the age range of the population and the length range of the catch length frequency distribution (LFD). ALK gap filling in terms of length classes is mandatory simply to ensure that the total number of fish in the length structure is conserved in the total number of fish once computed as an age structure. Gap filling in terms of ages as a representation of the population is more questionning, and methods to deal with age gaps are less documented.

During the last years, France has considered three methods for ALK gap filling, described below. To illustrate the methods, the ALK of sole in Division VIId (sol.27.7d) in quarter 2 of 2018 will be used.

The empirical ALK is given below as age-at-length frequencies, length have been grouped by 30mm classes to improve clarity of the presentation.

	2	3	4	5	6	7	8	9	10	11	12	13	15	16	18	10p
220	0.8	.	0.1	.	0.1	.	.	.	.	.	.	.	.	.	.	0
250	0.2	0.2	0.3	0.1	0	0.1	0.1	0	0	.	.	0	.	.	.	0
280	0	0.1	0.4	0.1	0	0.1	0.1	0	0	0	0	.	.	.	.	0.1
310	.	0	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0	0	0	.	0	.	0.1
340	.	0	0.2	0.2	0.2	0.1	0.1	0.1	0	0	0	0	.	.	.	0.1
370	.	.	0	0.2	0.1	0.1	0.4	0	0	.	.	.	.	.	.	0
400	.	.	.	.	.	0.1	0.2	0.3	0.2	.	.	.	.	.	0.1	0.3
430	.	.	.	.	.	.	0.5	.	.	.	.	.	0.5	.	.	0.5

Table 1: Empirical ALK of sole in the Eastern Channel (sol.27.7d) in quarter 2 of 2018. 10p represents the value for an age plus at 10.

It is noticeable that there is no individual at ages 0, 1, 14 and 17, and no ages for length classes 100, 130, 160, 190 and 460.The total number of fish effectively sampled is 556.

Using the multinomial distribution

The method has been published (Gerritsen, 2006) and implemented in the COST library (function fillALKmult). The method adds age-at-length for those length classes present in the samples for length with no corresponding ages. The method uses only the age groups available in the dataset. It is commonly used in preparing data for ICES assessment working groups. The method applied to the ALK of table 1 gives the filled ALK in table 2 below:

	2	3	4	5	6	7	8	9	10	11	12	13	15	16	18	10p
100	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
130	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
160	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
190	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
220	0.8	.	0.1	.	0.1	.	.	.	.	.	.	.	.	.	.	0
250	0.2	0.2	0.3	0.1	0	0.1	0.1	0	0	.	.	0	.	.	.	0
280	0	0.1	0.4	0.1	0	0.1	0.1	0	0	0	0	.	.	.	.	0.1
310	.	0	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0	0	0	.	0	.	0.1
340	.	0	0.2	0.2	0.2	0.1	0.1	0.1	0	0	0	0	.	.	.	0.1
370	.	.	0	0.2	0.1	0.1	0.4	0	0	.	.	.	.	.	.	0
400	.	.	.	.	.	0.1	0.2	0.3	0.2	.	.	.	.	.	0.1	0.3
430	.	.	.	.	.	.	0.5	.	.	.	.	.				
460	.	.	.	.	.	.	.	.	.	.	.	.				

Table 2: ALK filled by applying a multinomial distribution to the observed ALK of table 1. 10p represents the value for an age plus at 10.

The parameterisation of the method in the COST library gives the latitude to choose the number of individuals to be created per missing length classes. Here we have chosen 10, and this can be seen for length classes 100, 130, 160, 190 and 460 although for the latter only 9 is given due to a rounding effect. The total number of individuals used for the estimation is 605 and represents an increase of 49 individuals. If the rounding effect raises question, the solution is to increase the parameter to allow for integer values to better populate through the ages.

The method does not create missing ages, so the individuals created for length classes < 220 were all of age 2, which is unrealistic considering the growth of the species. This issue is well known among experts in assessment working groups, and can be counteracted by creating manually an individual of age 1 at length 130 for example, but this is totally arbitrary and difficult to implement in a full automatic procedure.

Using a truncated Von Bertalanffy growth curve

The application of a truncated Von Bertalanffy growth curve has been implemented by Ifremer since 2016 for most of the stocks, and has been used to reconstruct time series of data. It allows the use of the ALKs at all quarters to inform each of the quarters, since a quarterly growth curve allows the reuse of each individuals in each time period of the year. The truncation applies to the age range, and is parameterised to retain ages corresponding to 95% of the catches. The model uses all ages seen over the four quarters and will inform these ages in every quarter up to the truncated value. It allows for example to back calculate the young ages seen at the end of the year (Q4) through the earlier part of the year (Q1-3) using the Van Bertalanffy growth equation.

	0	1	2	3	4	5	6	7	8	9	10
100	0.7	0.3	.	.	.	.	.	.	.	.	.
130	0.5	0.5	.	.	.	.	.	.	.	.	.
160	0.2	0.8	.	.	.	.	.	.	.	.	.
190	.	0.2	0.5	0.2	.	.	.	.	.	.	.
220	.	0	0.7	0.1	0.1	.	0.1	.	.	.	.
250	.	.	0.2	0.2	0.3	0.1	0	0.1	0.1	0	0
280	.	.	0	0.1	0.4	0.2	0.1	0.1	0.1	0.1	0.1
310	.	.	.	0	0.1	0.2	0.1	0.1	0.2	0.1	0.1
340	.	.	.	0	0.2	0.2	0.2	0.2	0.1	0.1	0.1
370	.	.	.	.	0.1	0.2	0.1	0.1	0.4	0	0
400	.	.	.	.	.	.	.	0.1	0.2	0.3	0.3
430	.	.	.	.	.	.	.	.	0.5	.	0.5

Table 3: ALK filled by applying a truncated Von Bertalanffy growth curve to the observed ALK of table 1.

Ages 0 and 1 absent in Q2 were added from Q3 and Q4 and back calculated for Q1 and Q2. The age truncation was made at age 10, which in the model is an algorithmic 95 percentile of the age distribution, but can be also fixed by a user decision. The reconstruction of young ages performs well, but the function developed for filling gaps with VB growth curve is not replicable, since the output is the result of a random process. Another issue is the missing information at length class 460 (which comes at every run) although this length class is present in the observed length distribution.

Using a non-truncated Von Bertalanffy growth curve

The method was introduced in 2019 after a discussion in WGNSSK because the truncation at age 10 was younger than the age+ used for this stock (11). In consequence, age 10 gathering most of the older fish information was falsely seen as a true age. The removal of the truncation meant that all ages seen during the year were informed at each quarter. The benefits of the method for young ages played differently for the eldest.

	0	1	2	3	4	5	6	7	8	9	10	11
130	1	.	.	.	.	.	.	.	.	.	.	.
160	0.5	0.5	.	.	.	.	.	.	.	.	.	.
190	.	1	.	.	.	.	.	.	.	.	.	.
220	.	.	0.7	0.1	0.1	.	0.1	.	.	.	.	.
250	.	.	0.2	0.2	0.3	0.1	0	0.1	0.1	0	0	.
280	.	.	0	0.1	0.4	0.1	0	0.1	0.1	0	0	0
310	.	.	.	0	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0
340	.	.	.	0	0.1	0.1	0.2	0.1	0.1	0.1	0	0
370	.	.	.	.	0	0.1	0.1	0.1	0.3	0	0.1	.
400	.	.	.	.	.	.	.	0.1	0.2	0.3	0.2	.
430	.	.	.	.	.	.	.	0.3	0.3	.	.	.

	12	13	14	15	16	17	18	19	20	21	10p
130	.	.	.	.	.	.	.	.	.	.	0
160	.	.	.	.	.	.	.	.	.	.	0
190	.	.	.	.	.	.	.	.	.	.	0
220	.	.	.	.	.	.	.	.	.	.	0
250	.	0	.	.	.	.	.	.	.	.	0
280	0	.	.	.	0	.	0	.	.	0	0.1
310	0	0	0	0	0	.	.	0	0	.	0.2
340	0	0.1	0	.	0	0	0	.	.	0	0.3
370	0	.	.	0	0.1	0	.	0	0.1	0	0.3
400	.	.	.	0.1	.	0.1	0.1	.	.	.	0.4
430	.	.	.	0.3	.	.	.	.	.	.	0.3

Table 4: ALK filled by applying a non-truncated Von Bertalanffy growth curve to the observed ALK of table 1. 10p represents the value for an age plus at 10.

The upper left part of the ALK for smaller and younger fish seems to perform correctly. Note that the result is different from the truncated method, because it is a different run of the random function embedded within the method.

Comparison of the approaches

The next step is to investigate the impact of the method used to predict the complete ALK on the age composition, which is the input to the assessment. Below, the age composition derived from the combination of the estimated length distribution of the catches (landings + discards; figure 1) with the three methods used above for completed ALKs are compared for sole in the eastern Channel (sol.27.7d) in quarter 2 of 2018.

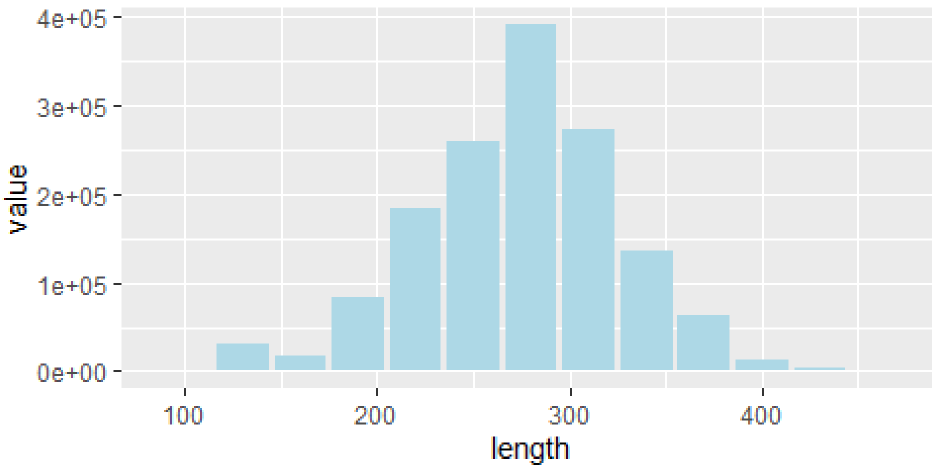

Figure 1: Length distribution of French catches (landings and discards) of sole in the eastern Channel (sol.27.7d) in quarter 2 of 2018.

For age groups 3 to 8, all approaches give similar results (figure 2, upper panel) or are varying extremely little, which is reassuring. The differences are major at ages 0, 1 and 2 and at ages 9+. For ages 0 and 1, only the VB models provides information, the difference between them residing in the underlying random process, something that can be discussed and fix in the future if the method is to be used. For age 2, the multinomial model is affecting all small fishes to this age group because ages 0 and 1 are absent of the samples.

For age groups >=9 (figure 2, lower panel), the multinomial is very conservative of the empirical data, the VB truncated at 10 emulates a +group at this age, as shows in the table 1, and the VB untruncated inflates the numbers at all ages older than 10. These features of the different models are confirmed in the table 5, where juveniles are composed of ages 0 and 1, adults of ages 2 to 9 and olds are ages 10 to 21.

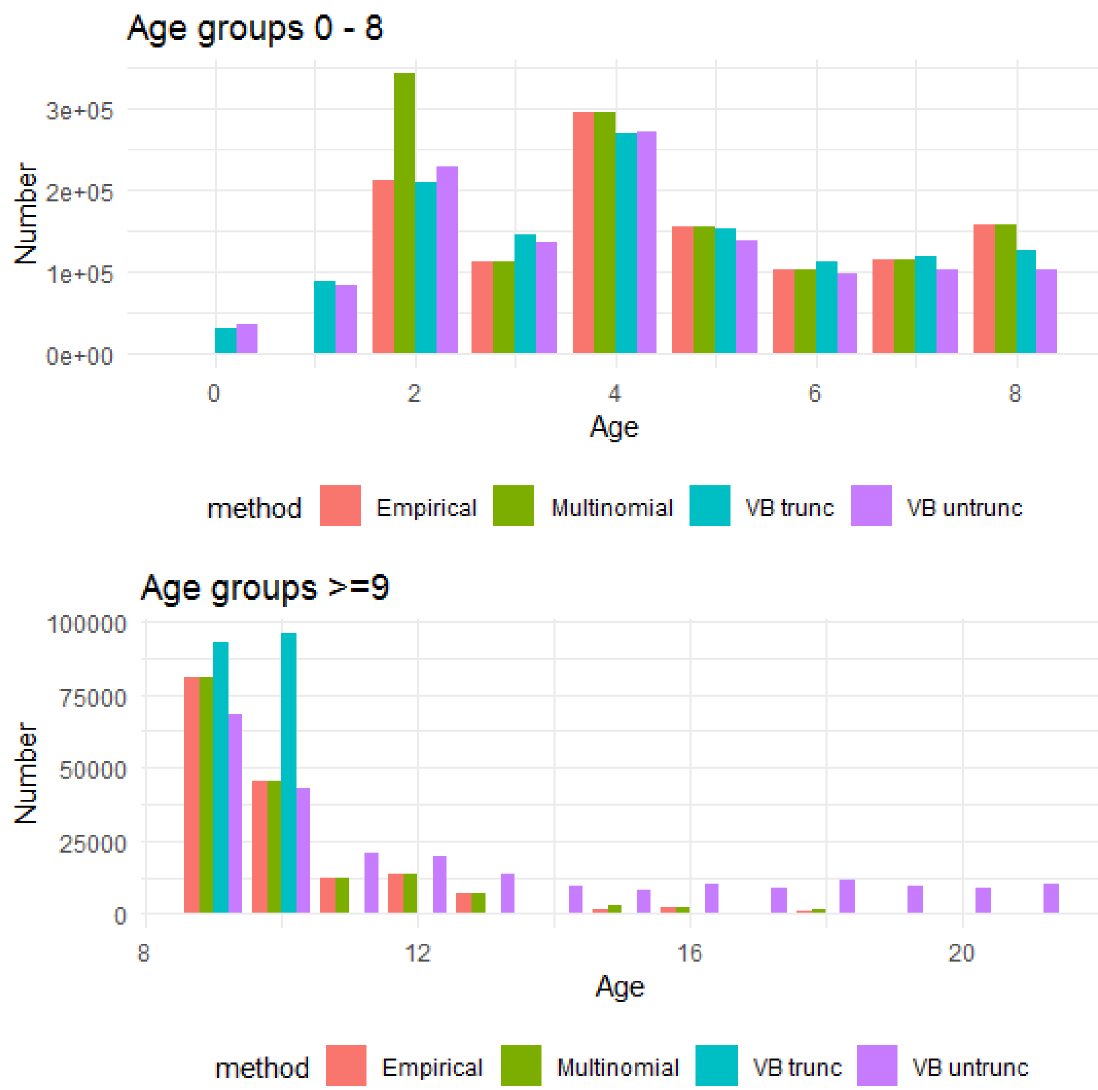

Figure 2: Comparison of the estimated age compositions of the catches of sole in the eastern Channel (sol.27.7d) in quarter 2 of 2018, estimated using the empirical ALK (table 1) and the 3 methods applied for filling gaps in age-at-length (tables 2-4) for age groups 0 â“ 8 (upper panel) and age groups>=9 (lower panel).

	Juveniles	Adults	Olds	Ratio
Empirical	-	1238608	83035	0.9097
Multinomial	-	1368698	84195	1
VB trunc	121443	1234443	95847	0.9992
VB untrunc	121245	1156174	174314	0.9992

Table 5: Estimated number of individuals caught in Q2 2018 for sol.27.7d spread by age groups and ALK gap filling methods (Juveniles: 0-1; Adults: 2-9; Olds: >10). The last column is the ratio between the total number of individuals in the age distribution over the same total in the length distribution.

The choice of the method for ALK gap filling has a huge impact on the age structure of the discards, and the use of growth curves to adjust the ALK towards the younger ages is coherent with the biology. The development of this method is mainly linked to the impossibility by law for French observers to disembark fish, and the subcontracting of the onboard observers made it very complex to include the collection of otoliths onboard. In consequence, the only source of small fish available is from scientific surveys, which occur once a year so that the corresponding ALK is attached to a single quarter. Using growth curve allows extending the age-at-length frequencies over the four quarters of a given year.

For the larger and older fish, the story is different, and the recent use of growth curves over all possible ages has had a potential impact on the AFD of the landings estimates. The truncation to the 95th percentile of the age range enabled to skip an old fish at the very end of the range and avoided the creation of all the intermediate ages, but the choice of the truncated age is arbitrary, may fluctuate from one year to another and may interfere with the age plus used in the assessment model.

Which and when stocks were impacted by the move from truncated to untruncated VB method

Identifying which stocks are impacted by the change is a difficult exercise. From table 6 below, it appears that sol.27.7d seems the most impacted with 11 ages difference between the truncated and the untruncated models and a 4.4 multiplication of the old individuals compared with an untruncated model. The other stocks have far less difference, with pok.27.3a46 having the same difference in age range and a 1.4 increase of the old individuals. The other stocks display fewer differences between the two methods.

	Y2017	Y2018	Y2019	multOld2019
bss.27.8ab	13	13	16	1.3
meg.27.7b-k8abd	9	8	-	-
pol.27.89a	12	-	-	-
sol.27.8ab	8	10	10	1.4
whg.27.89a	6	6	5	1.4
bss.27.4bc7d-h	14	14	16	1.7
cod.27.7e-k(1)	10	7	11	0.8
had.27.7b-k	9	10	10	1
ple.27.7fg	9	-	9	-
pol.27.67	7	-	-	-
sol.27.7e	8	12	11	0.5
whg.27.7b-ce-k	9	6	8	2.4
bli.27.5b67	23	21	17	-
gfb.27.nea	6	-	4	-
cod.27.47d20	8	8	7	2.4
mur.27.3a47d	5	6	4	-
ple.27.420	11	8	13	1.7
pok.27.3a46	12	8	19	1.4
sol.27.7d	9	10	21	4.4
whg.27.47d	10	9	8	0.5
lem.27.3a47d	-	7	5	-
ple.27.7d	-	8	11	0.9
sol.27.4	-	8	15	2.5
mur.27.67a-ce-k89a	-	6	3	-
ldb.meg.27.7b-k8abd.8c.9a	-	-	10	-
sol.27.7fg	-	-	15	-
ane.27.8	-	-	4	-

Table 6: age max used from 2017 to 2019 for the different stocks, using the data year 2016 for comparison, since 2016 has the potential of being estimated during the 3 assessment years. The last column represents the increase factor on older fish between 2018 and 2019 on the data year 2017, when 2017 was estimated during both assessment years. (1) cod-7e-k data provision follows an ad hoc procedure, not the generic procedure presented here.

The **solution for the future** resides in the generic use of the multinomial function embeded in the COST library but used only for landing at age estimates and for discards only for the quarters when younger ages are informed. Discards will also be provided at length for all quarters into InterCatch. The rebuilding of the age structures for stocks analysed in WKCELTIC and WKFlatNSCS will be submitted after discussion with ACOM. Since the use of the multinomial model was discontinued in 2016, we propose to upload all the data in response of the 2020 data call for the years 2016 - 2019. The upload of the full time series of any stock will also be possible.

Research should continue to fill ALK gaps with the best science and documented and validated methods, before the implementation phase.

Effort aggregating methods

Aggregating effort information has always been a challenge when dealing with fishing days and days at sea. The agreed rule is that the days at sea are calculated based on 24 hours sequences, and the fishing day is based on calendar days. So far, using fishing day as a raising variable to estimate discards is correct since the calendar day is what the COST function is using to estimate fishing day in the sample. Indeed, the ratio estimator for discards is $Y = X\hat{R} = X\frac{\sum_{i=1}^{n}\hat{y_i}}{\sum_{i=1}^{n}\hat{x_i}}$ where

- X is the total number of the raising variables in a stratum (i.e. fishing hours, fishing days, fishing operations, volume of landings, trips),
- $\hat{y_i}$ the estimated volume of discards in the samples and
- $\hat{x_i}$ the estimated number of the raising variable in the samples.

The difficulty is tied to the aggregation procedure when estimating the total number of fishing days in a stratified population, knowing that trips may pertain to several strata (gear/area) during the same journey and use different gears consecutively or in parallel. Castro Ribeiro et al (2016) compared MS approaches to effort aggregates and demonstrated the large difference between algorithms used, i.e. calendar days, sequences of 24h, rounding and fractioning methods and proposed a common methodology together with a corresponding R script. The common and agreed methodology fractions the fishing days when more than one gear has been used and/or more than one area has been visited during the day. Fractioning the fishing days to aggregate effort is the move done in 2019 to be more compliant with the international rules, anticipating the rule which is likely to be applied in the RDBES. The equation above derailed the discards estimates, since France chose some years ago to estimate discards raised by the fishing days and the COST function counts a full fishing day for each area*gear of the day in the sample, in other words does not fraction the day. Note that tuning series are using also effort and CPUE/LPUE information, but these are very often derived with ad hoc procedures based on individual fishing trips, thus not using the aggregates.

Statistically, any effort metric can be developed for aggregation and used as an auxiliary variable for discards raising, as long as the metric is calculated identically in the samples and in the population.

The comparison between discards estimated in 2019 (latest data submission of a given year: benchmark data call if one occurred for the stock) and the same discards estimated in 2017 and 2018 may be inferred when a given year has been estimated during these three years, and only a few stocks are in this case, and they are all used for the table 7.

	y2016in2019vsMean	y2017in2019vs2018
cod.27.6a	0.317	0.4872
cod.27.7e-k	0.5872	-
gur.27.3-8	0.342	0.1683
had.27.7b-k	0.5893	-
hom.27.2a4a5b6a7a-ce-k8	0.375	0.1916
hom.27.3a4bc7d	0.4396	0.3561
mac.27.nea	0.2673	0.1004
mur.27.67a-ce-k89a	0.2822	0.3959
pol.27.89a	0.429	1.179
sol.27.4	0.2298	0.1912
sol.27.7d	0.09012	0.1399
whb.27.1-91214	0.6987	1.043
whg.27.7b-ce-k	0.6065	0.5937

Table 7: Ratio between discards estimastes done in 2019 for the year 2016 vs the mean estimates between 2017 and 2018 (column 1) and for the year 2017 vs estimates in 2018 (column 2). Source: data sent to InterCatch.

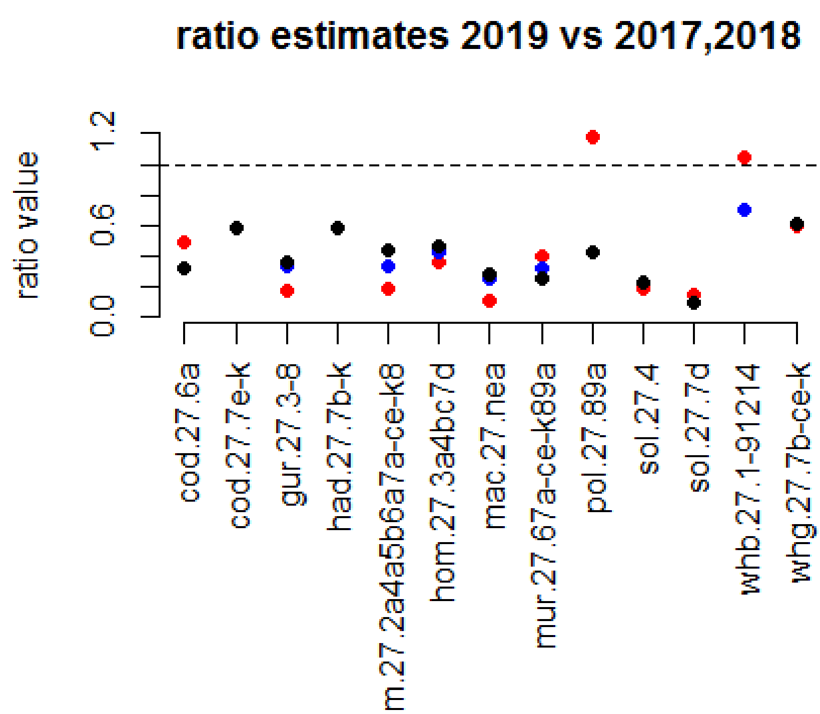

Figure 3: ratio between discards estimated in 2019 and 2018 for the year 2017 (red), for the year 2016 (blue) and between the estimation 2019 and the estimation 2017 for the year 2016 (black). Source: data sent to Intercatch.

The result of the move done in 2019 will differ from assessment working groups (AWG) depending if their effort aggregates were done before or after the move. The gathering of all the effort aggregates done from 2017 until now are compared for the main AWG and presented in Annex 2. The patterns for the different year estimates are repeated for all stocks of a given AWG. The discards estimates uploaded in 2019 are almost all impacted (Table 7, figure 3, Annex 1). The discards estimated in 2019 were far below the estimates provided in the previous years.

The **solution for the future** is

1. to stop immediately the use of fishing days as a raising variable for discards and use a proven solution used by many other countries, i.e. raising discards as a ratio of the landings of the given species. Some variant may be tested (ratio of the landings of the gender species or total species caught for e.g. elasmobranches);
2. To document the procedures used and implement a better quality check (in the likes of the figures in Annex 2);
3. To implement the algorithm internationally agreed for aggregating effort (creation of the CE table);
4. To reconstruct the full time series for all stocks, at a pace to be discussed with stock assessors and WG chairs. For example, the full time series of the stocks benchmarked in 2020 can be provided on demand.

An alert is given to all users of the COST libraries for estimating the discards based on the fishing days, because the COST estimation of fishing days in the samples is based on calendar days not fractioned.

Conclusions

The data preparation team has been deeply affected by the problems generated following our modifications of procedures and wishes to apologise to all experts having suffered from these. For the immediate future, the changes proposed have been expressed (use of multinomial model for ALK gap filling and abandon of the use of fishing days as an auxiliary variable for raising discards). Lessons are also taken for the long run, with the need to better Quality check the datasets between the moment they are available and the upload. We also need to proceed to a full review of the procedure and also assess the man power dedicated to the data processing, which we believe is a corner stone to good science, expertise and advice.

References

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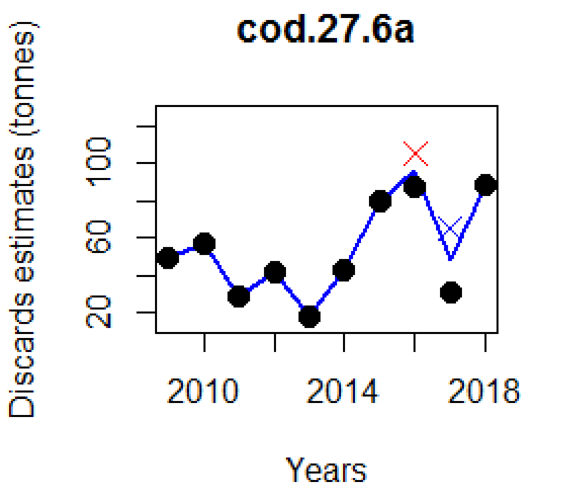
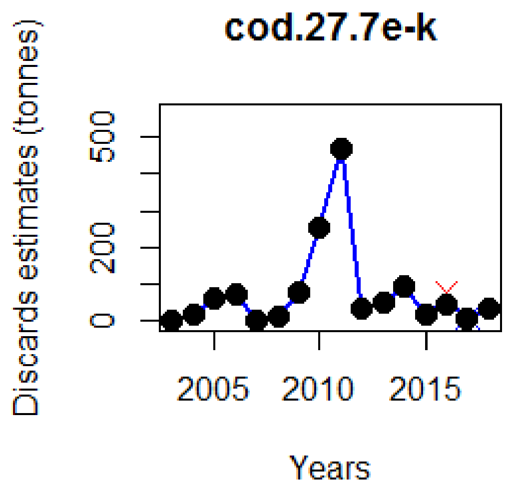
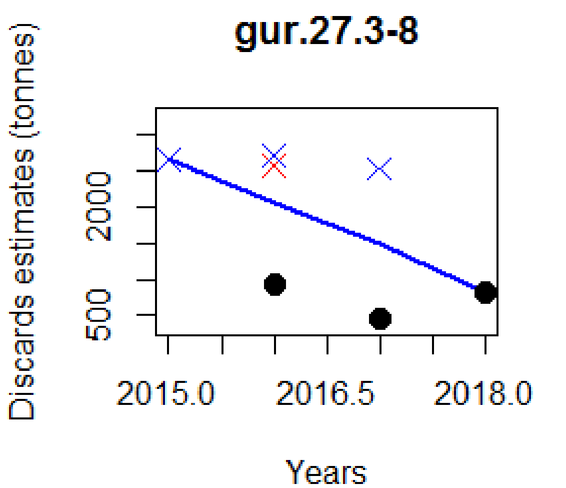
Decision EU 2010/93.head Commission Decision of 18 December 2009 adopting a multiannual Community programme for the collection, management and use of data in the fisheries sector forthe period 2011-2013 (2010/93/EU).

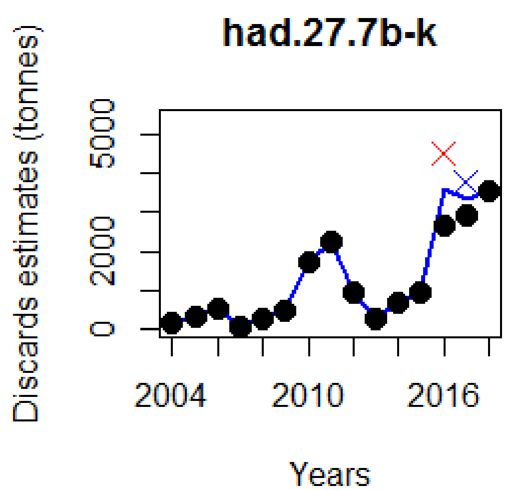
ANNEX 1: Comparison of discards estimates

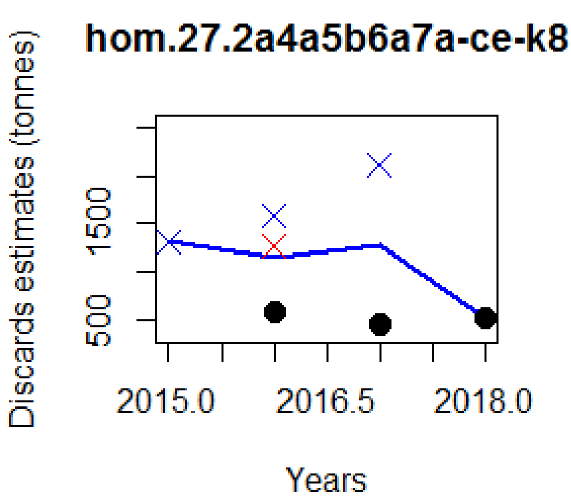
Stocks for which discards time series have been estimated at more than one occasion.

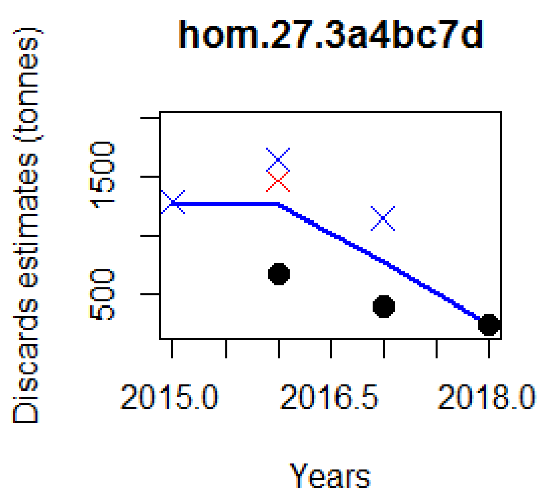


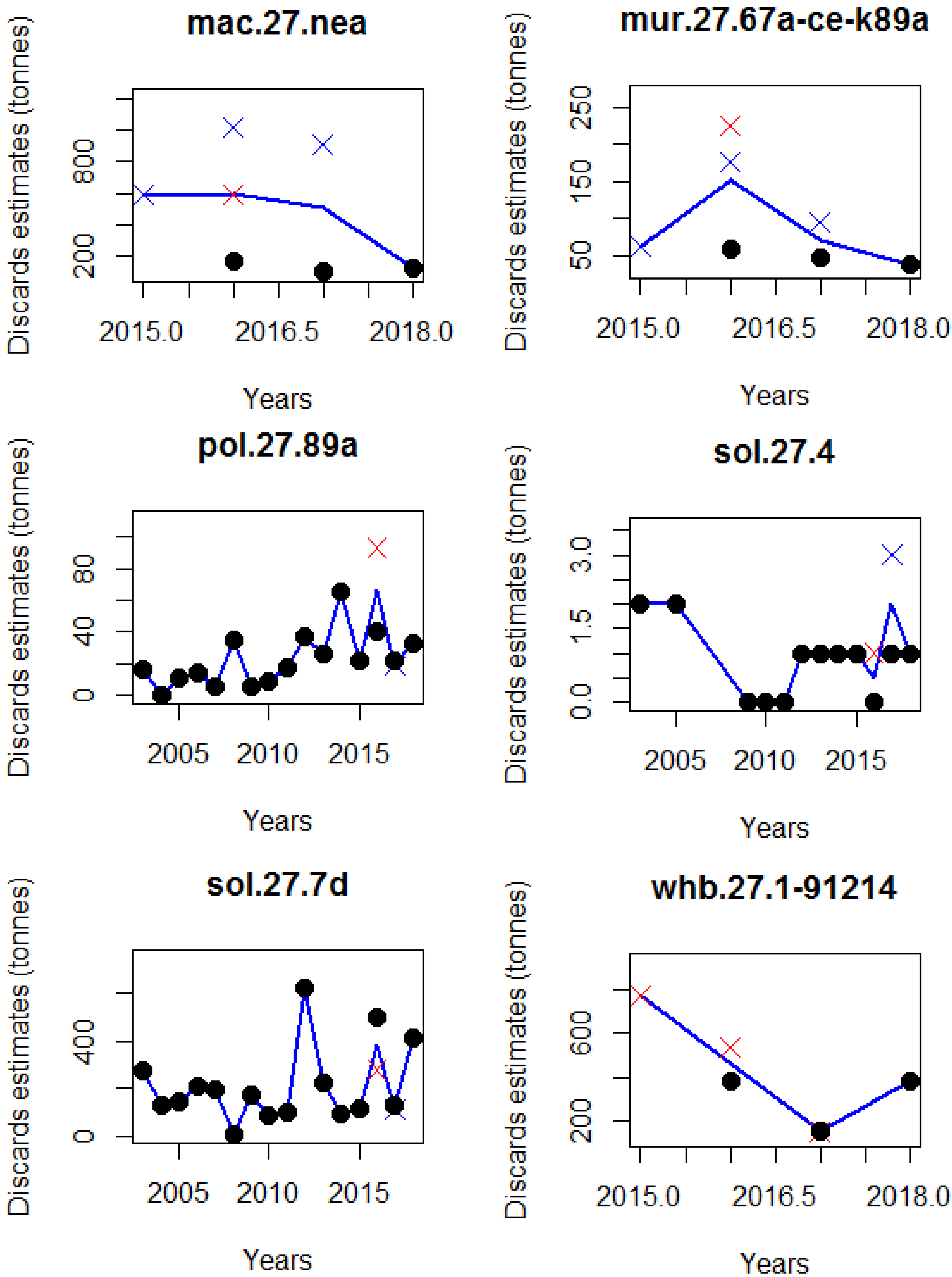


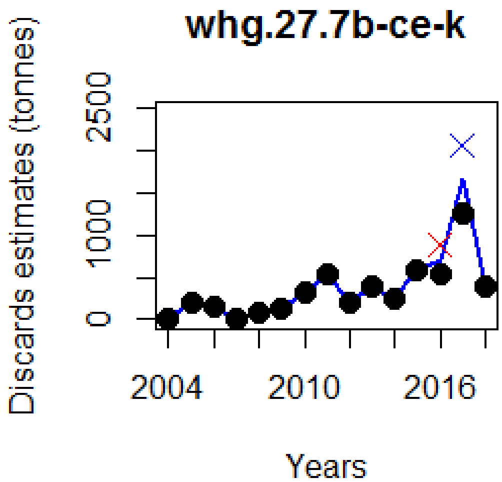









mac.27.nea
Discards estimates (tonnes)
200
800
2015.0
2016.5
2018.0
Years
mur.27.67a-ce-k89a
Discards estimates (tonnes)
50
150
250
2015.0
2016.5
2018.0
Years
pol.27.89a
Discards estimates (tonnes)
0
40
80
2005
2010
2015
Years
sol.27.4
Discards estimates (tonnes)
0.0
1.5
3.0
2005
2010
2015
Years
sol.27.7d
Discards estimates (tonnes)
0
400
2005
2010
2015
Years
whb.27.1-91214
Discards estimates (tonnes)
200
600
2015.0
2016.5
2018.0
Years



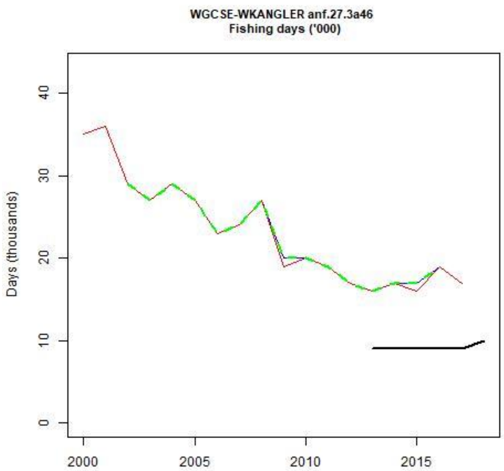
whg.27.7b-ce-k
Discards estimates (tonnes)
0
1000
2500
2004
2010
2016
Years

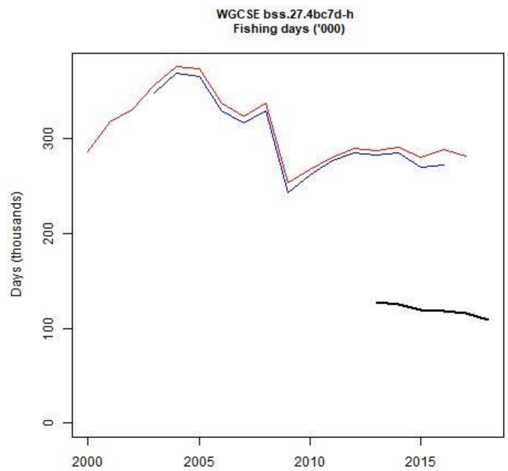
ANNEX 2: Comparison of effort aggregates

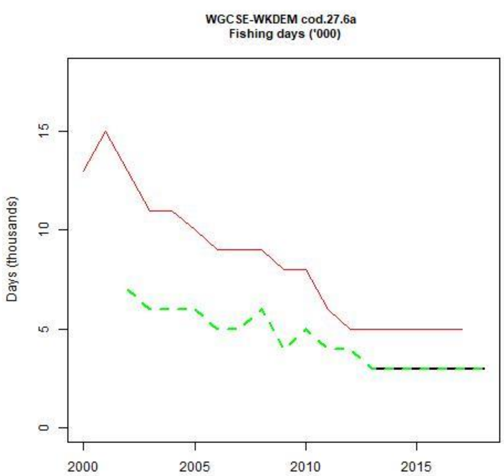
Stocks for which effort aggregates have been calculated at more than one occasion. Only a limited number of stocks are listed in this annex.

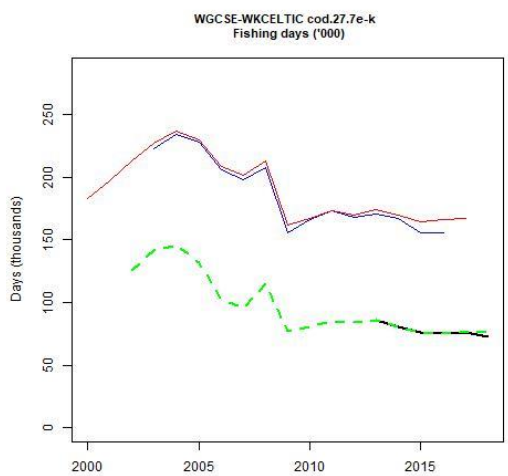
Legend - Blue line : dataset produced in 2017 in the WG noted in first place in the main title of the figure - Red line : data set produced in 2018 in the WG noted in first place in the main title of the figure - Black thick line : data set produced in 2019 in the WG noted in first place in the main title of the figure - Green thick dashed line : data set produced in the WG noted in second place in the main title of the figure

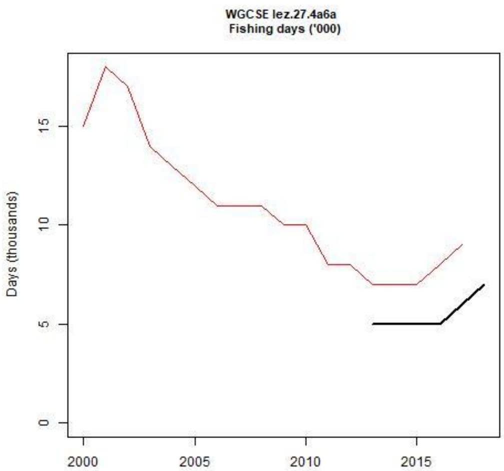
WGCSE Stocks

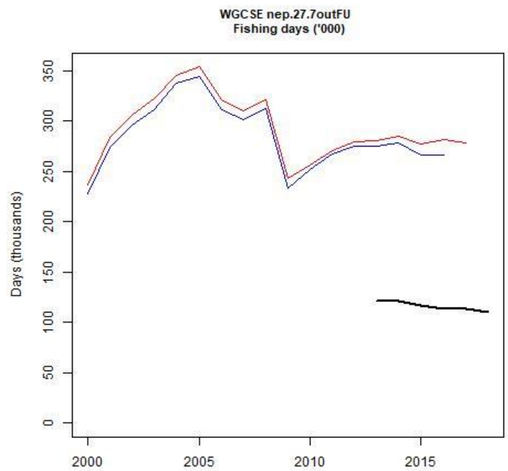


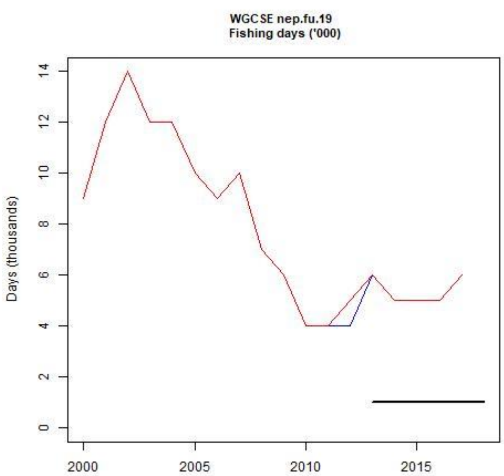


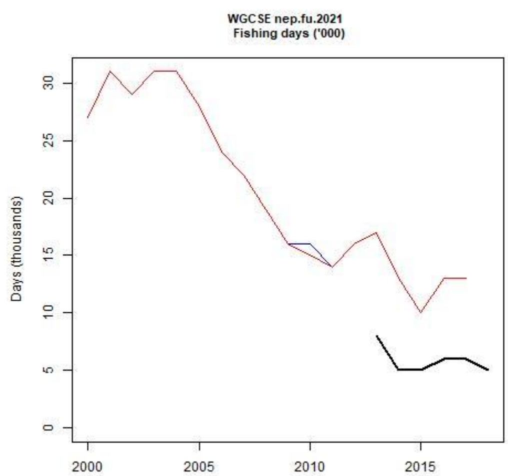


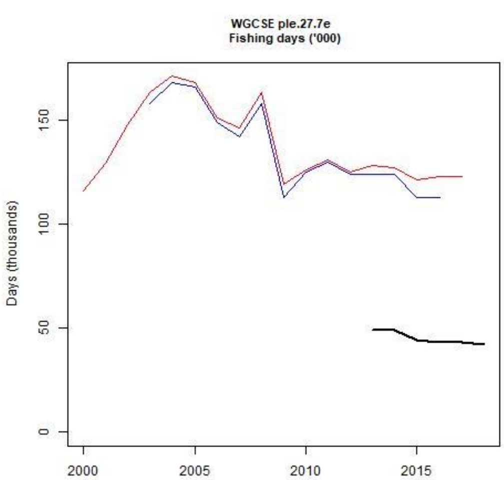


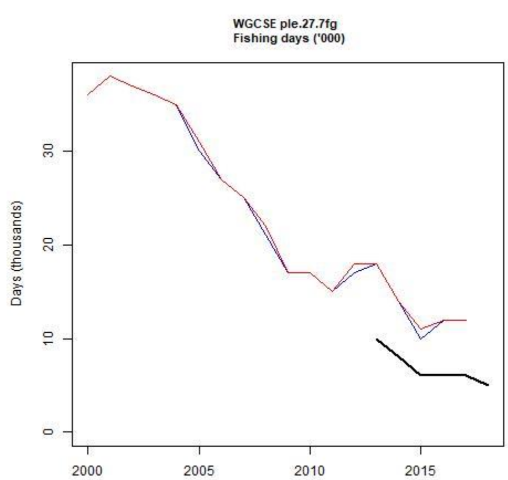

WGCSE lez.27.4a6a
Fishing days ('000)
Days (thousands)
0
5
10
15
2000
2005
2010
2015

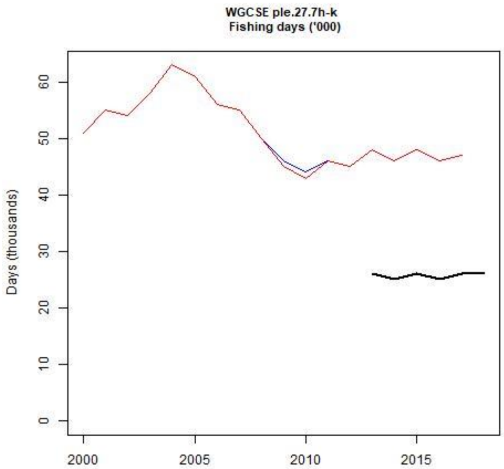

WGCSE nep.27.7outFU
Fishing days ('000)
Days (thousands)
0
50
100
150
200
250
300
350
2000
2005
2010
2015

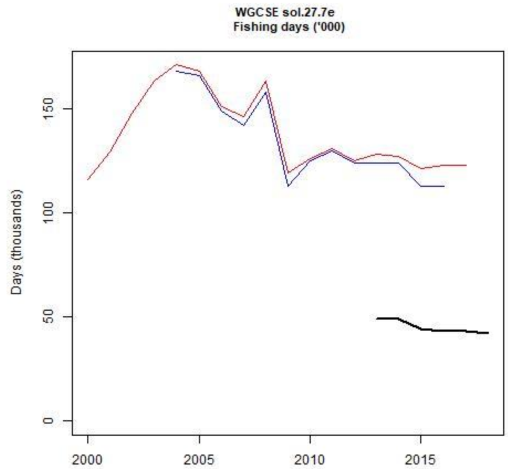

WGCSE nep.fu.19
Fishing days ('000)
Days (thousands)
0
2
4
6
8
10
12
14
2000
2005
2010
2015

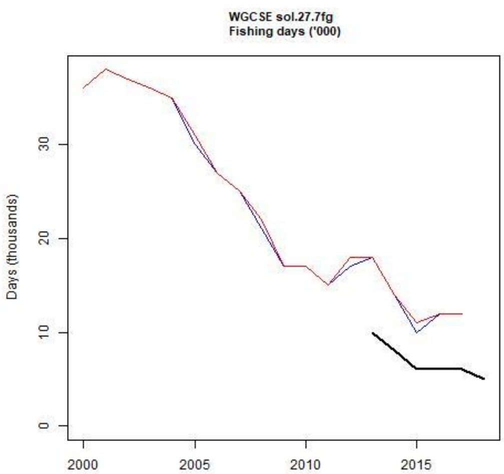

WGCSE nep.fu.2021
Fishing days ('000)
Days (thousands)
0
5
10
15
20
25
30
2000
2005
2010
2015

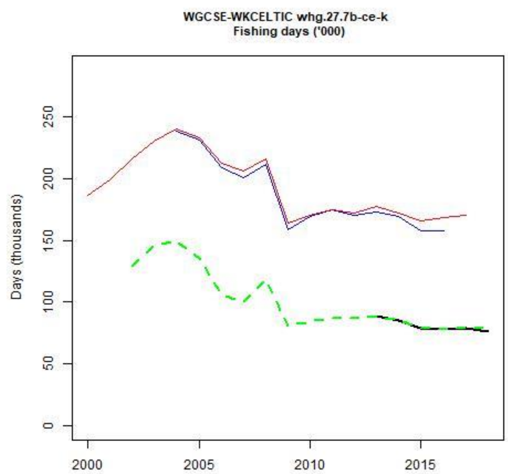

WGCSE ple.27.7e
Fishing days ('000)
Days (thousands)
0
50
100
150
2000
2005
2010
2015


WGCSE ple.27.7fg
Fishing days ('000)
Days (thousands)
0
10
20
30
2000
2005
2010
2015

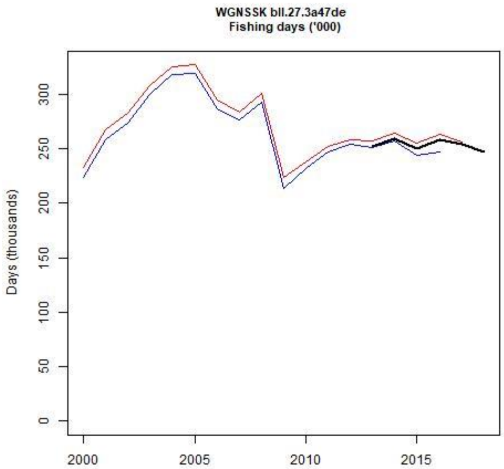

WGCSE ple.27.7h-k
Fishing days ('000)
Days (thousands)
0
10
20
30
40
50
60
2000
2005
2010
2015

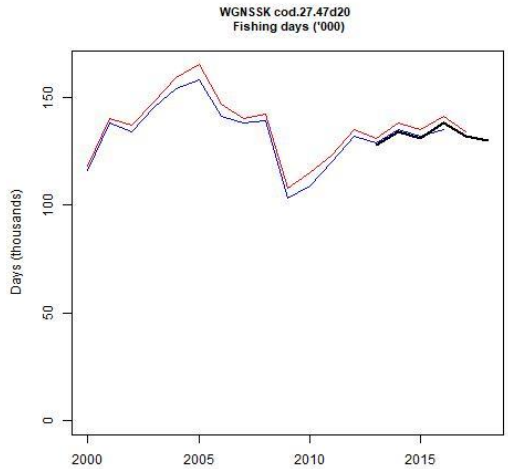

WGCSE sol.27.7e
Fishing days ('000)
Days (thousands)
0
50
100
150
2000
2005
2010
2015

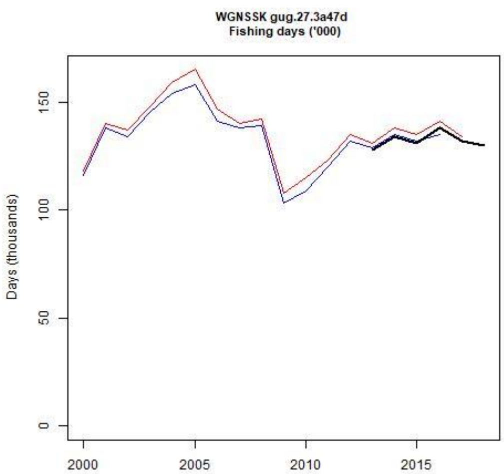

WGCSE sol.27.7fg
Fishing days ('000)
Days (thousands)
0
10
20
30
2000
2005
2010
2015

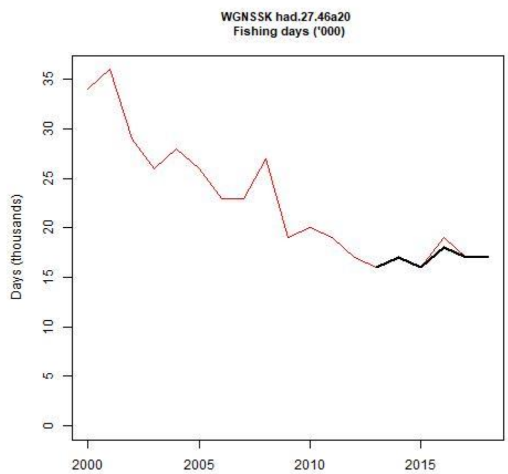

WGCSE-WKCELTIC whg.27.7b-ce-k
Fishing days ('000)
Days (thousands)
0
50
100
150
200
250
2000
2005
2010
2015

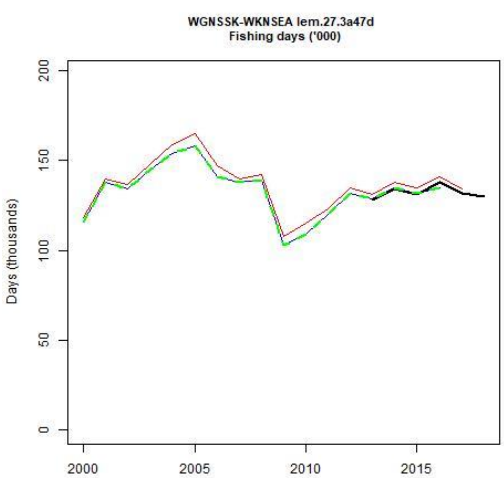
WGNSSK Stocks

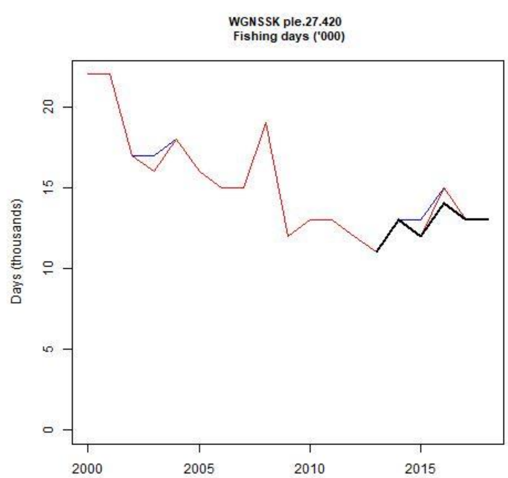


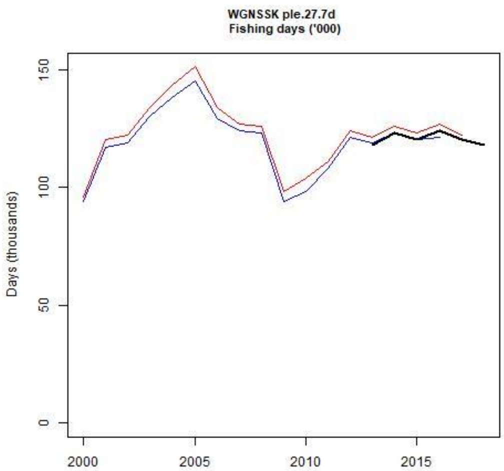


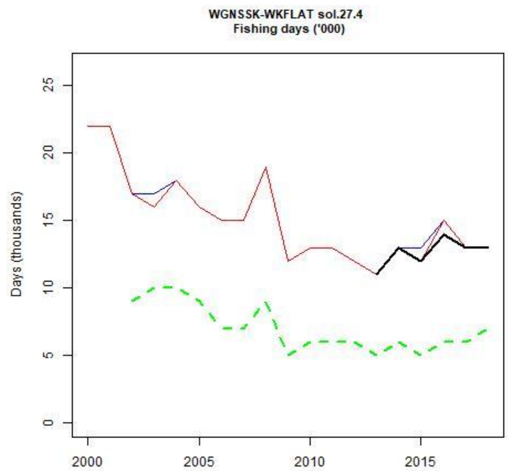


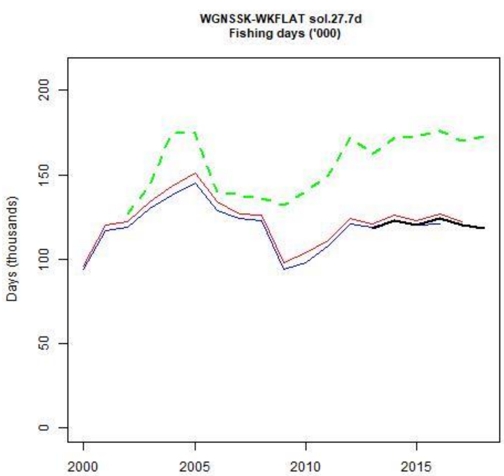


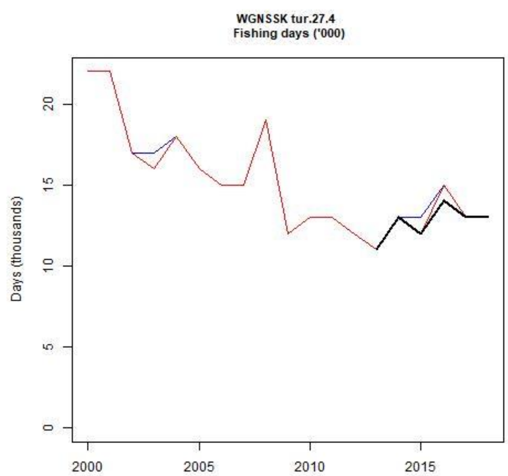


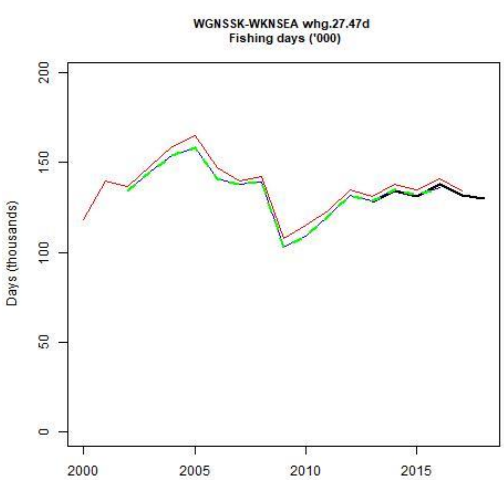


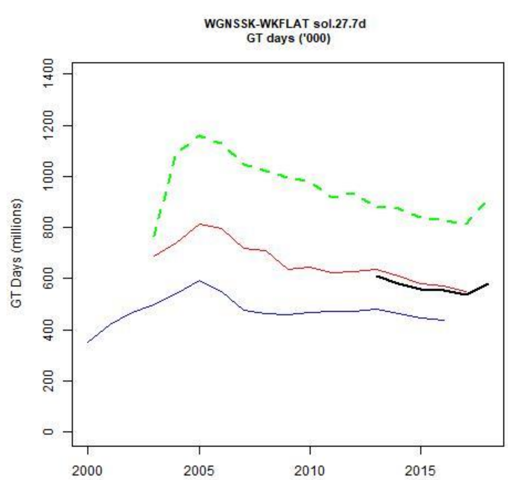

WGNSSK ple.27.7d
Fishing days ('000)
Days (thousands)
0
50
100
150
2000
2005
2010
2015


WGNSSK-WKFLAT sol.27.4
Fishing days ('000)
Days (thousands)
0
5
10
15
20
25
2000
2005
2010
2015

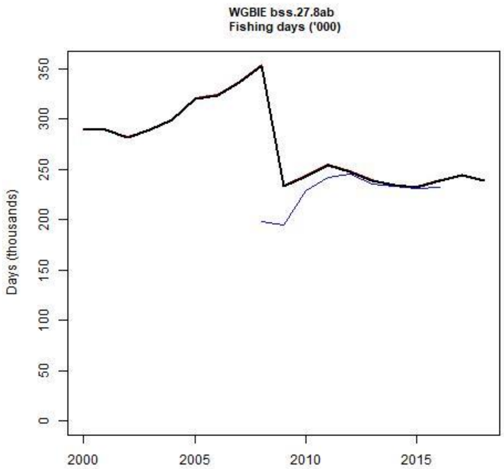

WGNSSK-WKFLAT sol.27.7d
Fishing days ('000)
Days (thousands)
0
50
100
150
200
2000
2005
2010
2015

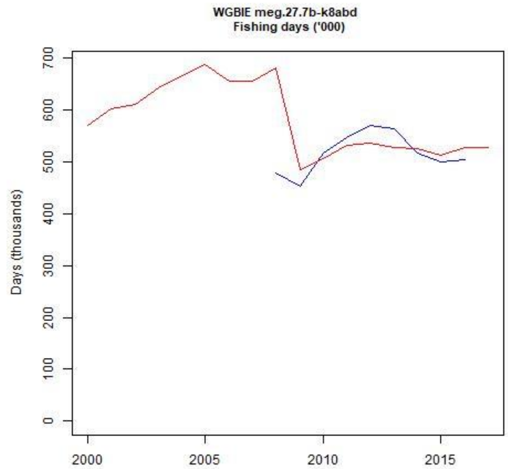

WGNSSK tur.27.4
Fishing days ('000)
Days (thousands)
0
5
10
15
20
2000
2005
2010
2015

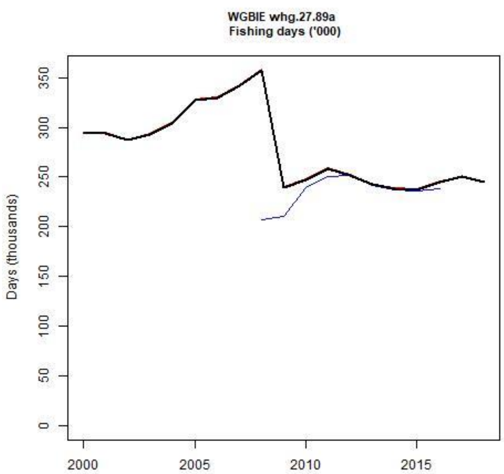

WGNSSK-WKNSEA whg.27.47d
Fishing days ('000)
Days (thousands)
0
50
100
150
200
2000
2005
2010
2015


WGNSSK-WKFLAT sol.27.7d
GT days ('000)
GT Days (millions)
0
200
400
600
800
1000
1200
1400
2000
2005
2010
2015

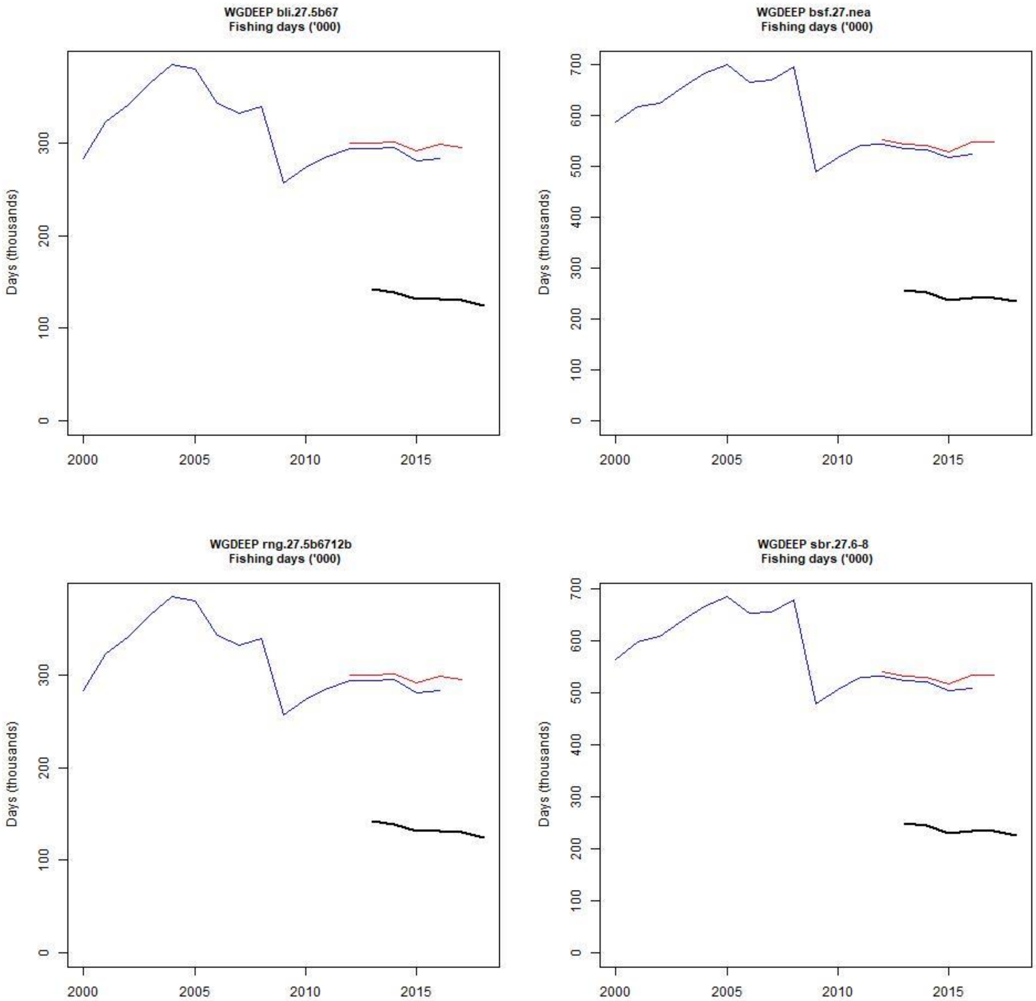
WGBIE Stocks



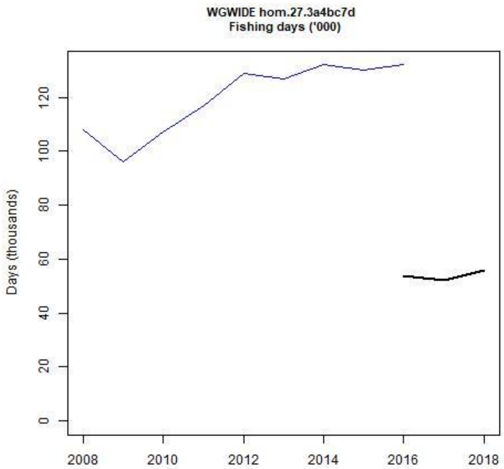


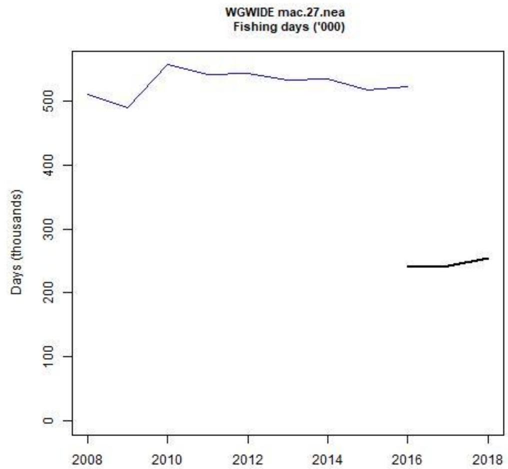


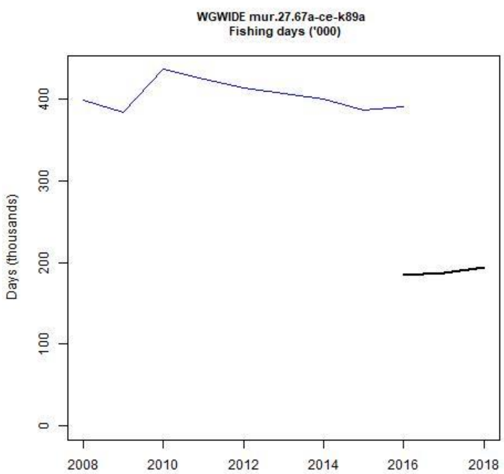
WGDEEP Stocks



WIDE Stocks


WGWIDE hom.27.3a4bc7d
Fishing days ('000)
Days (thousands)
0
20
40
60
80
100
120
2008
2010
2012
2014
2016
2018


WGWIDE mac.27.nea
Fishing days ('000)
Days (thousands)
0
100
200
300
400
500
2008
2010
2012
2014
2016
2018


WGWIDE mur.27.67a-ce-k89a
Fishing days ('000)
Days (thousands)
0
100
200
300
400
2008
2010
2012
2014
2016
2018