

## Annex 8: Working documents

### Working Document 1: Update and correction of the reference points, estimated during the 2019 IBP, for saithe in areas 3a, 4 and 6

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#### 1.1. Background

Following identifications of several issues with the commercial CPUE index used in the pok.27.3a46 assessment and subsequent corrections (see Section 16 of the main report), an attempt was made to evaluate possible impacts of the updated series on the reference point estimates.

#### 1.2. Methods and new issues identified

The reference points (RPs) for pok.27.3a46 were formerly re-estimated during an inter-benchmark protocol (IBP) in early 2019, following detection of an erroneous standardization of  $F$  within the assessment model. The IBP report (ICES, 2019) documents the new reference points to be based on corrected runs of the 2018 assessment (with data up to 2017) using the last 5 years of selectivity pattern within the EqSim model, instead of the 10 years used previously. This shortening of the selectivity series used in EqSim was motivated by notable recent changes in the selectivity for ages 3 and 4.

The methodology used here to evaluate the potential effect of the most recent changes (as of 2021 assessment) on the reference points was to (i) make sure we could replicate the 2019 IBP results using saved 2018 assessment outputs, (ii) replicate the whole process including the 2018 assessment using the data used then (check for consistency in assessment outputs) and (iii) compare calculated reference point using the newly corrected CPUE index (calculated on corrected data 2000-2017). In order to account for the stochasticity in the EqSim model outputs, RP estimation was run 150 times (25 SR-fit x 6 EqSim simulations) for each scenario, and RP distributions were compared to each other and to the point estimates from the 2019 IBP.

Step *i* revealed itself more problematic than expected as some reported RPs such as  $F_{lim}$  (and derived  $F_{pa}$ ) or  $F_{p05}$  (with management rule) were falling far out the newly estimated distributions (Fig. **Error! Reference source not found..a**). Fortunately, saved R objects of the EqSim runs used to estimate the RPs in 2019 allowed for a detailed investigation of the reasons behind the discrepancies. It appeared that the EqSim runs used to estimate those RPs (no HCR nor  $F$  variability, and HCR+ $F$  variability) had been using the 2016 stock assessment outputs with the last 10 years of selectivity pattern (Fig. **Error! Reference source not found.**) instead of the 2018 assessment and the last 5 years of selectivity.

$F_{MSY}$ ,  $MSY$  and the stock status reference points, all based on the run with  $F$  variability and no management rule (first case in Fig. **Error! Reference source not found.**), were unaffected by this mistake. Similarly, the stock status RPs not based on

EqSim but relying on the stock-recruitment relationship analysis instead ( $B_{lim} = B_{loss}$  and  $B_{trigger} = B_{pa} = B_{lim} \times e^{1.645 \times 0.2}$  in this case), were exhibiting negligible changes. This is consistent with the overall limited effect of the CPUE index update on the stock assessment outcomes.

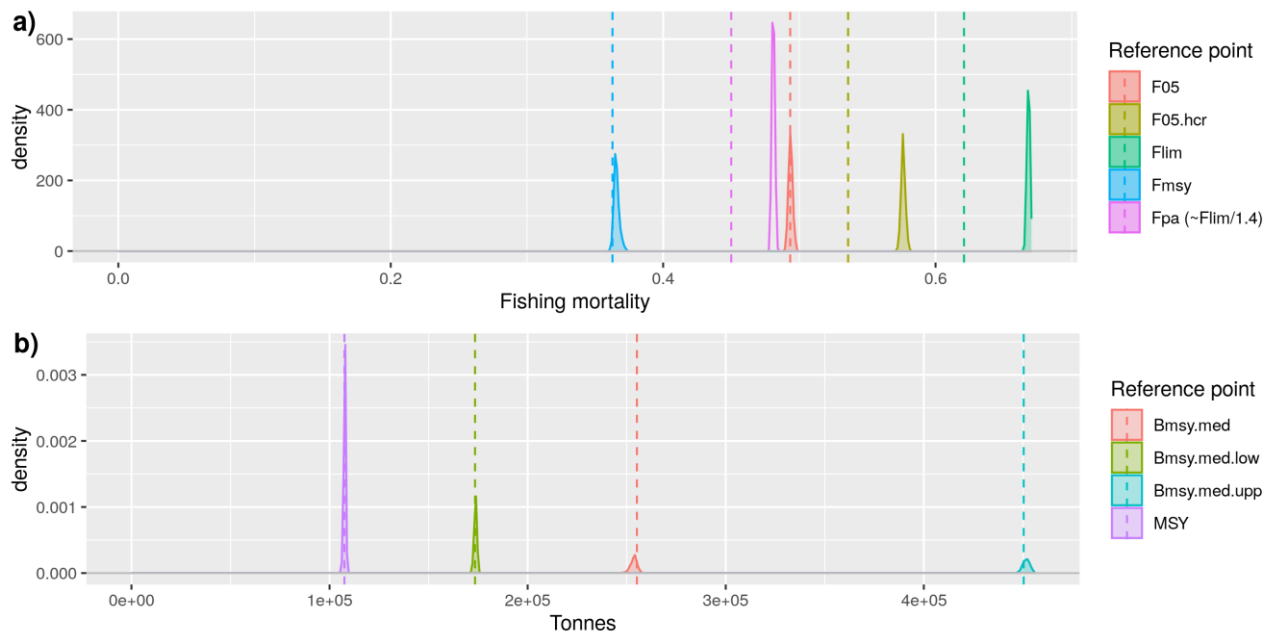


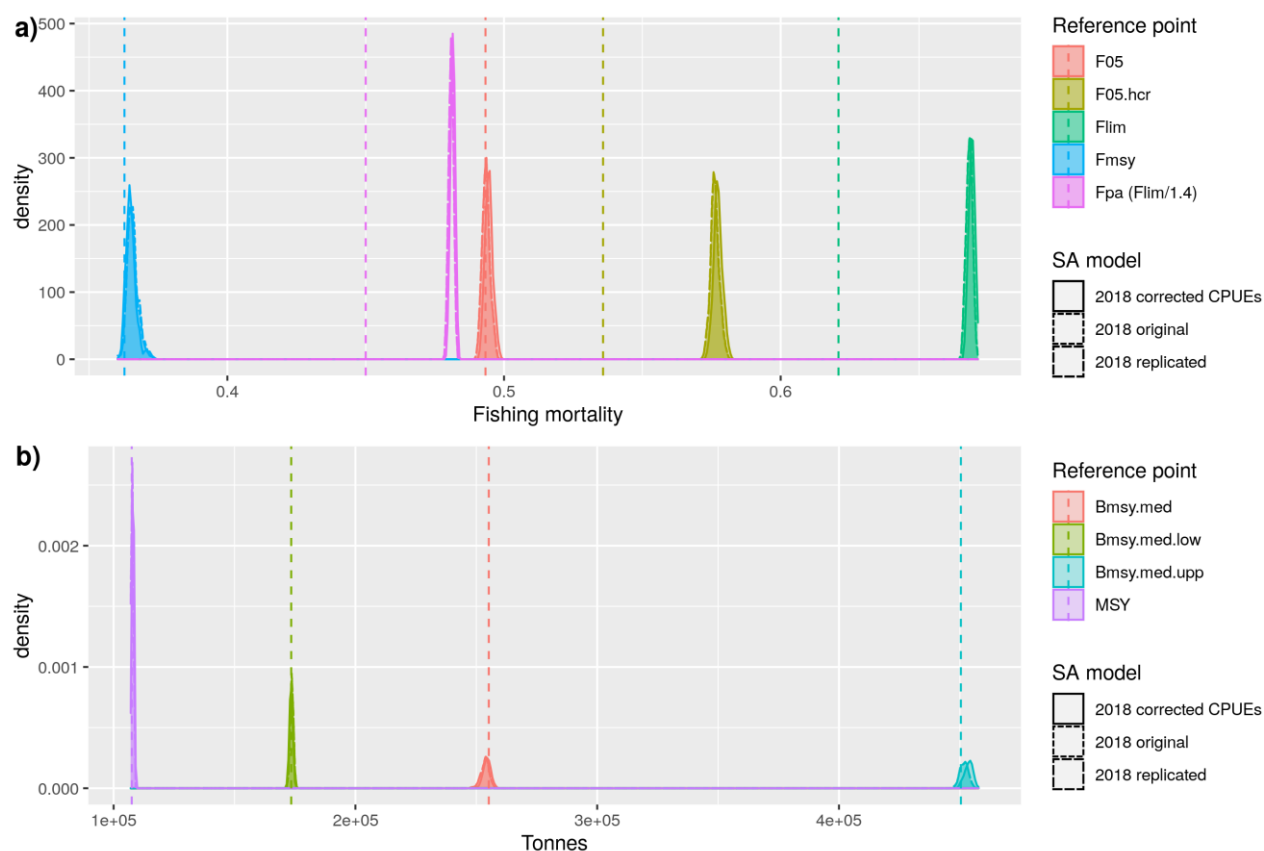
Figure 1. Estimation of reference points using saved 2018 stock assessment outputs (corrected for the 2019 IBP), using settings *documented in the IBP report* (distributions). The vertical dashed lines are the point estimates reported. *With* a) F-based reference points and b) biomass/weight-based reference points.

Run settings (RPs)	Selectivity patterns 2019 IBP								Selectivity patterns 2021					
No HCR, F <sub>c</sub> v + F <sub>φ</sub> (F <sub>MSY</sub> ,...)									Age	2013	2014	2015	2016	2017
									3	0.28	0.26	0.25	0.23	0.22
									4	0.85	0.82	0.82	0.80	0.78
									5	1.09	1.09	1.10	1.10	1.09
									6	1.09	1.10	1.10	1.10	1.12
									7	0.98	0.99	0.98	1.00	1.02
									8	0.95	0.97	0.97	1.01	1.02
									9	0.87	0.90	0.91	0.96	0.97
									10+	0.87	0.90	0.91	0.96	0.97
No HCR, F <sub>c</sub> v=F <sub>φ</sub> =0 (F <sub>lim</sub> )	Age								2013	2014	2015			
	3	0.40	0.40	0.37	0.35	0.32	0.34	0.31	0.28	0.26	0.25			
	4	0.88	0.91	0.90	0.88	0.86	0.89	0.88	0.85	0.82	0.82			
	5	1.02	1.05	1.07	1.07	1.07	1.09	1.10	1.09	1.09	1.10			
	6	1.10	1.08	1.08	1.09	1.08	1.06	1.07	1.09	1.10	1.10			
	7	1.01	0.96	0.96	0.96	0.98	0.96	0.95	0.98	0.99	0.98			
	8	0.96	0.90	0.90	0.89	0.93	0.91	0.92	0.95	0.97	0.97			
	9	0.95	0.87	0.86	0.83	0.84	0.83	0.84	0.87	0.90	0.91			
	10+	0.95	0.87	0.86	0.83	0.84	0.83	0.84	0.87	0.90	0.91			
HCR, F <sub>c</sub> v + F <sub>φ</sub> (F <sub>p.05</sub> ,...)									Age	2013	2014	2015	2016	2017
									3	0.28	0.26	0.25	0.23	0.22
									4	0.85	0.82	0.82	0.80	0.78
									5	1.09	1.09	1.10	1.10	1.09
									6	1.09	1.10	1.10	1.10	1.12
									7	0.98	0.99	0.98	1.00	1.02
									8	0.95	0.97	0.97	1.01	1.02
									9	0.87	0.90	0.91	0.96	0.97
									10+	0.87	0.90	0.91	0.96	0.97

Figure 2. Comparison of selectivity patterns used for different EqSim runs from the 2019 IBP (extracted from saved EqSim objects) with those documented in the report and replicated in 2021 (“as they should be”). Selectivity years in 2019 (red headings) as guessed after match of selectivities with the 2021 runs.

### 1.3. Reference points comparisons

The reference points calculated using the updated CPUE index were therefore compared to RP based on 2018 saved and re-ran assessments using the last 5 years (2013–2017) of selectivity, as documented in the 2019 IBP report (i.e., as they should have been; ICES, 2019). The distributions based on the saved (“original”, as calculated in 2019) stock assessment outputs and the replicated 2018 stock assessment match perfectly, which demonstrate consistency in the model outputs (Fig. **Error! Reference source not found.**). RP distributions estimated based on the corrected CPUE index overlap mostly the former ones, and the point estimates not wrongly estimated (see previous section) all fall within the newly estimated distributions. This shows that the CPUE update has a negligible impact on the reference point estimates. Following new ICES technical guidelines (ICES, 2021), the  $F_{pa}$  reference point should therefore be set to the newly estimated median value of  $F_{p05}$  using the advice rule ( $F_{05.hcr}=0.58$  in Fig. **Error! Reference source not found.**) instead of the erroneous value ( $F_{p05}=0.54$ ) previously reported by ICES (2019).  $F_{05.hcr}$  also constituted the technical basis for MAP  $F_{upper}$ , which should also be updated accordingly:  $F_{MSY upper}$  (0.564, unchanged) being now more conservative than the corrected value of  $F_{p05}$ , it becomes the new technical basis for MAP  $F_{upper}$ . And finally,  $F_{lim}$ , wrongly estimated during the 2019 IBP, should be raised from 0.62 to 0.69.



**Figure 3. Comparisons of *reference point* estimates (distributions) based on historical 2018 assessment and with corrected CPUE index. Parametrisation of the EqSim simulations as documented in the 2019 IBP report. Vertical dashed lines are the reported point estimates, some (F-based RPs) of which were based on erroneous settings. With a) F-based reference points and b) biomass/weight-based reference points.**

#### 1.4. Note on the technical basis for $B_{pa}$

The 2019 IBP set  $MSY B_{trigger} = B_{pa}$  on the basis that the stock had been fished over  $F_{MSY}$  for at least one of the last five years (2013-2017) and following ICES (2017). The updated 2018 stock assessment (corrected CPUE index), on the other hand, reveals a possible exploitation below  $F_{MSY}$  for just five years, which could prompt a change of technical basis for  $MSY B_{trigger}$ . More recent stock assessment, including the 2021 one, however do not support the view of stock which has been consistently exploited within or below  $F_{MSY}$  over the last years, and a change of technical basis for  $MSY B_{trigger}$  is not advisable.

#### 1.5. Acknowledgements

Mistakes happen, especially when dealing with urgent requests. As the newly appointed stock coordinator, I would like to highlight the value of – and warmly thank the then coordinator for – thoroughly documenting and saving the scripts and results from the 2019 IBP. This immensely helped figuring out and solving the issue at hand.

#### 1.6. References

- ICES. 2017. Technical Guidelines - ICES fisheries management reference points for category 1 and 2 stocks. [http://www.ices.dk/sites/pub/Publication Reports/Forms/DispForm.aspx?ID=32751](http://www.ices.dk/sites/pub/Publication%20Reports/Forms/DispForm.aspx?ID=32751) (Accessed 27 April 2021).
- ICES. 2019. Report of the Interbenchmark protocol on North Sea saithe (IBPNSsaithe). [http://www.ices.dk/sites/pub/Publication Reports/Forms/DispForm.aspx?ID=35210](http://www.ices.dk/sites/pub/Publication%20Reports/Forms/DispForm.aspx?ID=35210) (Accessed 23 April 2021).
- ICES. 2021. Technical Guidelines - ICES fisheries management reference points for category 1 and 2 stocks (2021). [https://www.ices.dk/sites/pub/Publication Reports/Forms/DispForm.aspx?ID=37356](https://www.ices.dk/sites/pub/Publication%20Reports/Forms/DispForm.aspx?ID=37356) (Accessed 23 April 2021).

# Working Document 2: Exploration of SPiCT forecast for Brill in 27.3a47de

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## 1.1. Introduction

The brill stock in the greater North Sea (27.3a47de) is a category 3 stock, for which the 2 over 3 rule is applied to the Dutch commercial standardised LPUE biomass index (vessels > 221 kW). A SPiCT assessment including landings, the Dutch commercial lpue index and the BTS-ISIS Q3 survey index is run to determine whether the precautionary (PA) buffer should be applied.

WKLIFE X (ICES, 2020) investigated the performance of harvest control rules across life-history types through simulation and management strategy evaluation (MSE) for data-limited stocks such as brill in the greater North Sea. Recommendations include the application of the SPiCT forecast to provide advice.

This working document compares the current way of providing advice (2 over 3 rule) with the recommendations from WKLIFE X.

### 1.1.1. Current advice: 2 over 3 rule applied to biomass index

For the current brill 27.3a47de advice, the ICES framework for category 3 stocks is applied (ICES, 2021a). The standardised landings per unit effort (lpue) from the Dutch beam-trawl fleet (vessels > 221 kW) was used as biomass index of stock development (Figure 1). The advice is based on the ratio of the mean of the last two index values (index A; Figure 1 red lines) with the mean of the three preceding values (index B) multiplied by the recent advised catch. This results in a 8.3% decrease for the 2022 catch advice compared to the 2021 catch advice (Table 1; ICES, 2021b).

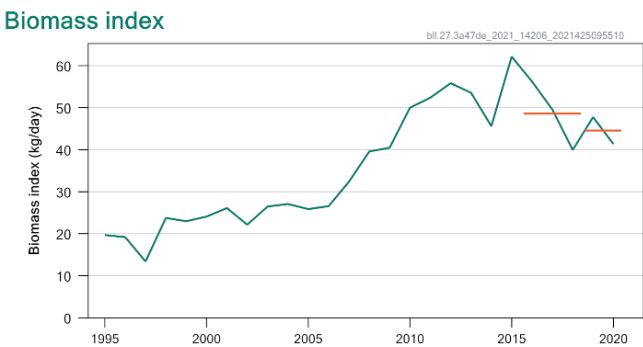


Figure 1: Biomass index as presented in the advice for 2022, showing the standardised landings per unit effort (lpue) from the Dutch beam-trawl fleet (vessels > 221 kW). The red horizontal lines indicate the average of the biomass index for 2019-2020 and for 2016-2018.

Table 1: 2022 Advice for Brill 27.3a47de

Index A (2019–2020)	45 kg d <sup>-1</sup>	
Index B (2016–2018)	49 kg d <sup>-1</sup>	
Index ratio (A/B)	0.92	
Uncertainty cap	Not applied	-
Advised catch for 2021	2047 tonnes	
Discard rate (2018–2020)	14.3%	
Precautionary buffer	Not applied	-

Catch advice *	1878 tonnes
Projected landings corresponding to catch advice **	1610 tonnes
% advice change^	-8.3%

\* [Advised catch for 2021] × [Index ratio].

\*\* [Advised catch for 2021] × [Index ratio] × [1 – discard rate].

^ Advice value for 2022 relative to the advice value for 2021.

## 1.2. SPiCT

To determine whether a precautionary buffer needs to be applied, a SPiCT assessment is run to verify stock status relative to proxy reference points.

The SPiCT assessment was first run during the WGNSSK 2017 and includes 1) landings data truncated from 1987 to the last data year, 2) a BTS-ISI-Q3 survey index (1987 to the last data year) and 3) the standardized lpue index from the Dutch beam-trawl fleet (vessels > 221 kW) from 1995 to the last data year. Settings include priors set to default (ICES, 2017a).

The SPiCT model results are shown in Figure 2. These results suggest that the relative fishing mortality is below the reference  $F_{MSY}$  proxy and the relative biomass is well-above the reference  $B_{MSY}^*$  0.5 proxy. Therefore, the Precautionary Approach Buffer (PA Buffer) was not applied for the advice for this stock.

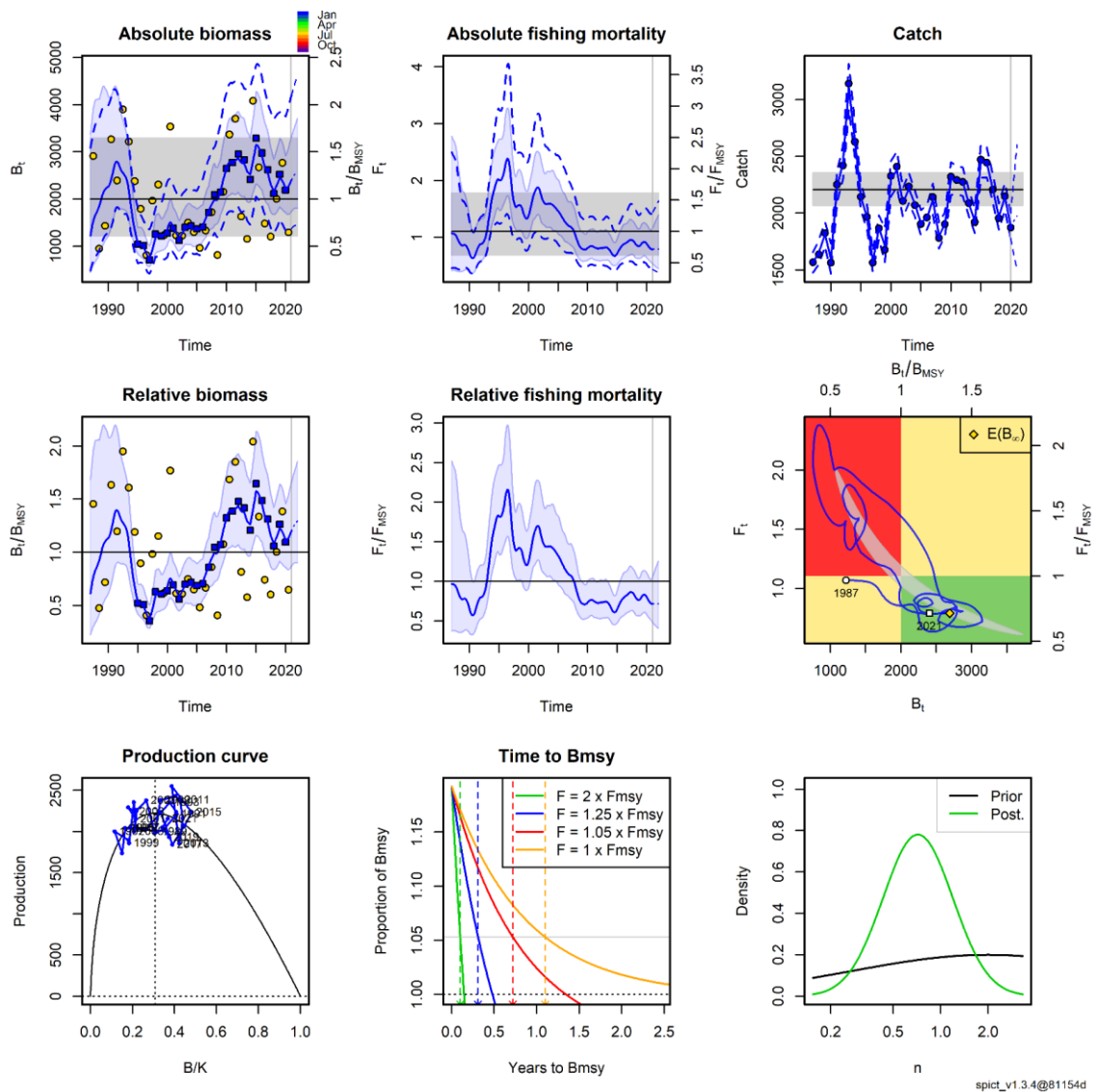
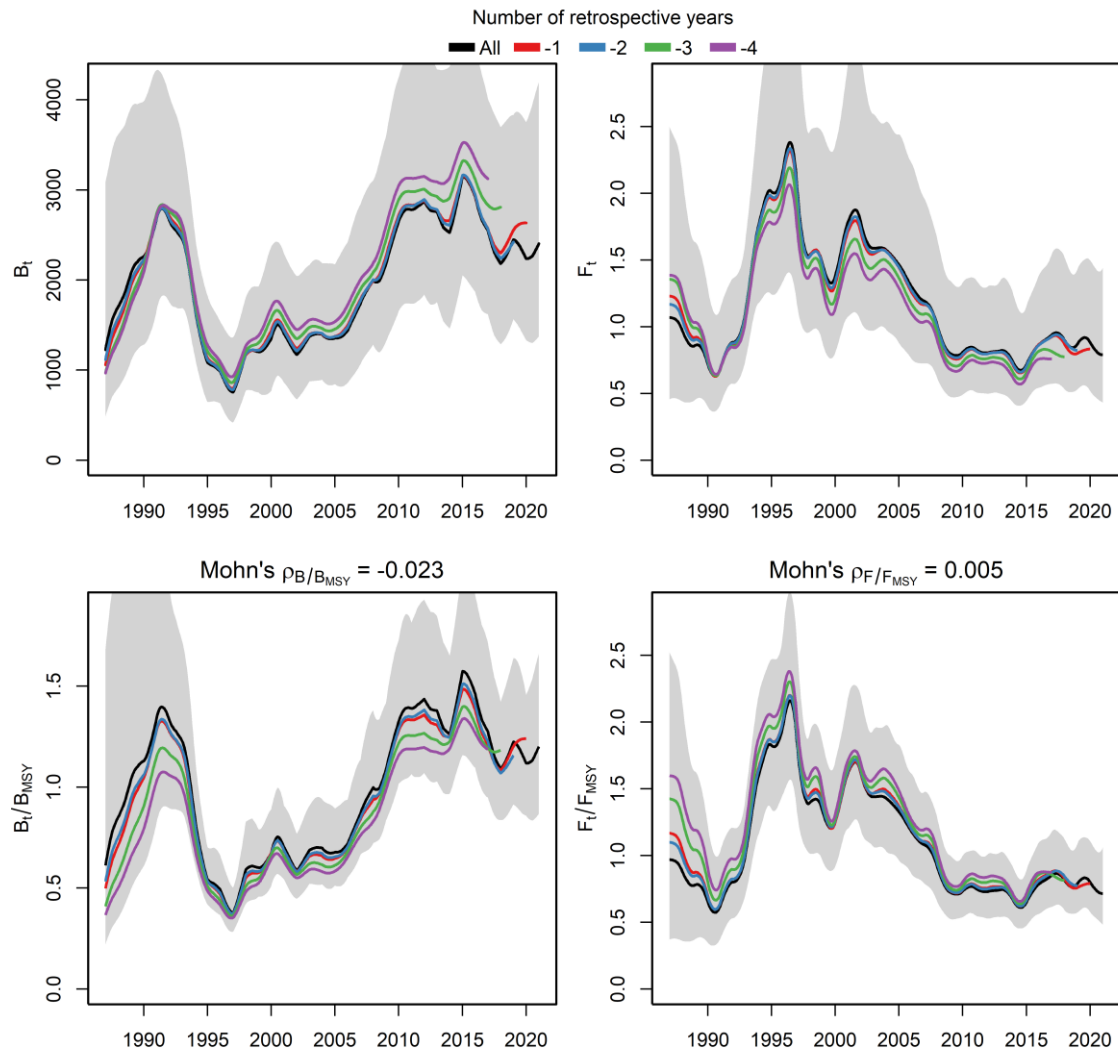


Figure 2: SPiCT model results from WGNSSK 2021. Top row: absolute biomass, absolute  $F$  estimates, and fitted catch. Middle row: relative biomass and  $F$ , and a Kobe plot comparing biomass and  $F$ . The grey area in the Kobe plot represents the uncertainty in the relative biomass and  $F$  estimates. Bottom row: production curve, estimated time to  $B_{MSY}$ , and prior and posterior parameter distributions. The dashed lines are 95% CI bounds for absolute estimated values, shaded blue regions are 95% CIs for relative estimates, shaded grey regions are 95% CIs for estimated absolute reference points (horizontal lines).

The retrospective analysis shows a stable pattern, with all peels within the confidence bounds (Figure 3). Moreover, the Mohn's Rho values for  $F/F_{MSY}$  (0.005) and  $B/B_{MSY}$  (-0.023) were low. It was concluded that the model performed well and that the estimated stock status with respect to reference points is consistent.



spict\_v1.3.4@81154d

Figure 3: Retrospective analysis of the SPiCT model from WGNSSK 2021. Top row: absolute biomass and absolute  $F$ ; bottom row: relative biomass and relative  $F$ .

### 1.3. SPiCT forecast scenarios: median versus fractile rule

For stocks that have an accepted SPiCT assessment, WKLLIFE X recommends to use the fractile rule with 35<sup>th</sup> percentile of the predicted catch distribution. In theory, with increasing time series and decreasing observation error, the estimated catch should approximate the median rule suggested by WKMSYCat34 while being more precautionary (ICES, 2017b).

Two intermediate year settings were tested for the forecast: 1)  $F$  status quo ( $F_{sq}$ ), which allows a continuation of the  $F$  processes, but does not specify any catch parameters in the intermediate year 2) TAC constraint, which considers the advised landings for 2021 as catch for the intermediate year (TAC for the whole year in 2021 is not available). **Considering that the input data are only landings, the output of the forecasts will also be landings advice.**

#### 1) $F$ status quo:

For the intermediate year settings, a continuation of the  $F$  processes was assumed ( $F_{sq}$ ). Four catch scenarios were explored for the management period (2022-2023). An overview is given in Table 2 and Figure 4. The  $F_{sq}$  scenario in 2022-2023 gives the landings when assuming a further continuation



of the  $F$  processes beyond the intermediate year ( $F_{2022} = F_{2021}$ ).  $F_{MSY}$  in 2022-2023 is defined as  $F/F_{MSY}$  equal to 1. The proposed 35% fractile rule suggests a 2444 tonnes landings advice for 2022.

Table 2: SPiCT forecast output showing catch scenarios for the  $F$  status quo option in the intermediate year.

$F$ in 2022-2023	Landings advice 2022	$B/B_{MSY}$ (2023)	$F/F_{MSY}$ (2022-2023)
$F = 0$	0	2.2	0.00
$F = F_{sq}$	2069	1.32	0.72
$F_{MSY}$	2592	1.08	1.00
$F_{MSY}$ 35% fractile	<b>2444</b>	1.15	0.91

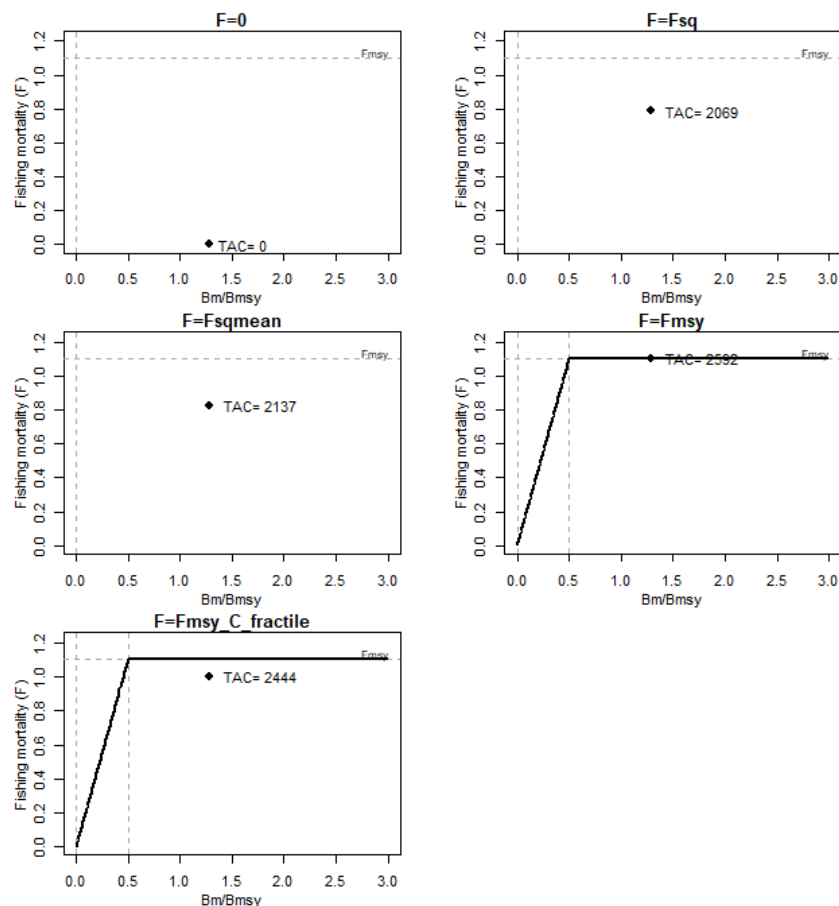


Figure 4: Visualisation of the catch scenarios for the  $F$  status quo option in the intermediate year. Vertical dashed lines for  $B/B_{MSY}$  indicate  $B_{lim}$  ( $B/B_{MSY} = 0$ ) and  $B_{MSY}$  proxy ( $B/B_{MSY} = 0.5$ ). Horizontal dashed line indicates  $F_{MSY}$  proxy.

## 2) TAC constraint

The landings advice for 2021 (1773 tonnes) was used as intermediate period catch, in absence of the 2021 TAC. Four catch scenarios were explored for the management period (2022-2023). An overview is given in Table 3 and Figure 5. The  $F_{sq}$  scenario in 2022-2023 gives the landings when assuming a further continuation of the  $F$  processes from 2020 in 2022-2023 ( $F_{2022} = F_{2021}$ ).  $F_{MSY}$  in 2022-2023 is defined as  $F/F_{MSY}$  equal to 1. The proposed 35% fractile rule suggests a 2530 tonnes landings advice for 2022.

Table 3: SPiCT forecast output showing catch scenarios for the TAC constraint option in the intermediate year.

$F$ in 2022-2023	Landings advice 2022	$B/B_{MSY}$ (2023)	$F/F_{MSY}$ (2022-2023)
$F = 0$	0	2.2	0.00
$F = F_{sq}$	1904	1.43	0.62

<b>F<sub>MSY</sub></b>	2657	1.09	1.00
<b>F<sub>MSY</sub> 35% fractile</b>	<b>2530</b>	<b>1.15</b>	<b>0.93</b>

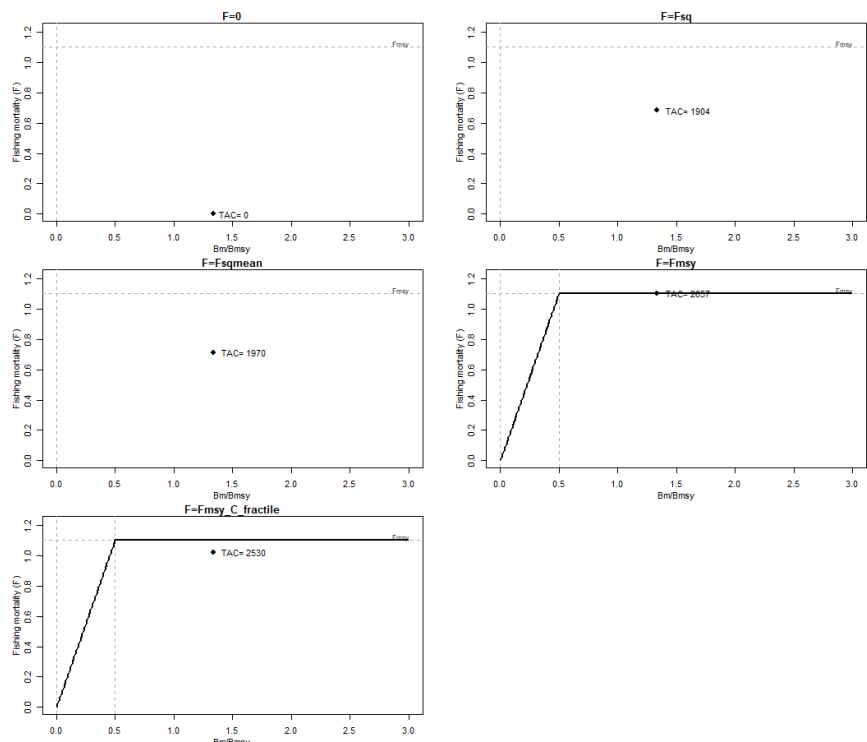


Figure 5: Visualisation of the catch scenarios for the TAC constraint option in the intermediate year. Vertical dashed lines for  $B/B_{MSY}$  indicate  $B_{lim}$  ( $B/B_{MSY} = 0$ ) and  $B_{MSY\ proxy}$  ( $B/B_{MSY} = 0.5$ ). Horizontal dashed line indicates  $F_{MSY\ proxy}$ .

### 1.4. Conclusion

Using the 35% fractile approach, landings advice is 2444 tonnes for the F status quo option in the intermediate year. The TAC constraint option gives a landings advice of 2530 tonnes. Comparing this with the current landings advice based on the 2:3 rule (1610 tonnes), there is a difference of 52% for the first option and 57% for the TAC constraint option.

Based on the output of the SPiCT assessment, the brill stock is currently in a good state compared to proxy reference points. Consequently, it is not unusual to expect higher advice using the SPiCT forecast. Furthermore, the Dutch lpue index currently used for advice only covers a part of the stock area (only area 27.4). It is also a raw index (not modelled), which could be improved considering the changes in the Dutch beam trawl fleet (introduction and phasing-out of pulse trawlers).

Applying a precautionary approach to give advice for this stock is necessary. Not only is brill in 27.3a47de a data limited stock, management of brill and turbot also occurs under a combined species TAC (applied to area 27.2a and 27.4). The latter prevents effective control of the single-species exploitation rates and could lead to the overexploitation of either species. ICES advises that management should be implemented at the species level in the entire stock distribution area (Subarea 4 and divisions 3.a and 7.d–e for brill and 27.4 for turbot) and not applying advice for the whole stock area of brill (27.3a47de) to only area 27.4.

## 1.5. References

ICES, 2017a. Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK). ICES Scientific Reports. <https://doi.org/10.17895/ices.pub.5323>

ICES, 2017b. Report of the Workshop on the Development of the ICES approach to providing MSY advice for category 3 and 4 stocks (WKMSYCat34), 6–10 March 2017, Copenhagen, Denmark. ICES CM 2017/ACOM:47. 53 pp.

ICES, 2020. Tenth Workshop on the Development of Quantitative Assessment Methodologies based on LIFE-history traits, exploitation characteristics, and other relevant parameters for data-limited stocks (WKLIFE X). ICES Scientific Reports. 2:98. 72 pp. <http://doi.org/10.17895/ices.pub.5985>

ICES. 2021a. Advice on fishing opportunities. In Report of the ICES Advisory Committee, 2021. ICES Advice 2021, section 1.1.1. <https://doi.org/10.17895/ices.advice.7720>.

ICES. 2021b. Working Group on the Assessment of Demersal Stocks in the North Sea and Skagerrak (WGNSSK). ICES Scientific Reports. 3:66. <https://doi.org/10.17895/ices.pub.8211>.

## 1.6. Annex:

SPiCT forecast output for the option without specific intermediate year assumption:

```
sumspict.manage(fit, include.abs = TRUE)
SPiCT timeline:
```

Observations	Intermediate	Management
1987.00 - 2021.00	2021.00 - 2022.00	2022.00 - 2023.00
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Management evaluation: 2023.00

Predicted catch for management period and states at management evaluation time:

	C	B/Bmsy	F/Fmsy	B	F	perc.dB	perc.dF
1. F=0	0.0	2.20	0.00	4435.6	0.00	72.0	-100.0
2. F=Fsq	2069.1	1.32	0.72	2650.4	0.79	2.8	0.0
3. F=Fsqmean	2136.8	1.29	0.75	2589.6	0.83	0.4	4.6
4. F=Fmsy	2592.3	1.08	1.00	2173.5	1.10	-15.7	39.8
5. F=Fmsy_C_fractile	2443.9	1.15	0.91	2310.6	1.01	-10.4	27.4

SPiCT forecast code for the TAC constraint option, defining the TAC as the landings advice for 2021 (1773 tonnes).

```
sumspict.manage(fit2, include.abs=TRUE)
SPiCT timeline:
```

Observations	Intermediate	Management
1987.00 - 2021.00	2021.00 - 2022.00	2022.00 - 2023.00
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Management evaluation: 2023.00

Predicted catch for management period and states at management evaluation time:

	C	B/Bmsy	F/Fmsy	B	F	perc.dB	perc.dF
1. F=0	0.0	2.24	0.00	4498.9	0.00	68.8	-100.0
2. F=Fsq	1904.4	1.43	0.62	2874.9	0.68	7.9	0.0
3. F=Fsqmean	1969.8	1.40	0.65	2817.3	0.71	5.7	4.6
4. F=Fmsy	2656.6	1.09	1.00	2200.1	1.10	-17.4	61.6
5. F=Fmsy_C_fractile	2529.5	1.15	0.93	2316.3	1.02	-13.1	49.7