

# NEAFC request concerning long-term management strategy for herring in the Northeast Atlantic (Norwegian spring-spawning herring)

# Advice summary

# *Please note:* The present advice has been updated to include the evaluation of the long-term management strategy options chosen by the Coastal States in October 2018.<sup>‡</sup>

ICES has evaluated the long-term management strategy (LTMS) for Norwegian Spring-Spawning (Atlanto-Scandian) Herring. The harvest control rule (HCR) proposed for the LTMS is found to be consistent with the precautionary approach. In addition, the HCR remains precautionary when constraints on interannual TAC change are added (-20%/+25%), and is also robust to 10% banking or borrowing of quota between years.

ICES has additionally evaluated the harvest control rules proposed for the Norwegian spring-spawning herring stock as requested by NEAFC. The options that are precautionary and maximize the long-term yield are identified in the tables. Comparing short-, medium-, and long-term results, for the HCRs without a constraint on the interannual variation of the TAC, a main conclusion is that, for any given [F<sub>target</sub>, B<sub>trigger</sub>] or [HR<sub>target</sub>, B<sub>trigger</sub>] combinations, the probability (P) of SSB falling below B<sub>lim</sub> [P(SSB< B<sub>lim</sub>)] is highest for the medium term for all rules tested. This is as expected, given the current low stock size. Generally, the rules with two biomass trigger points (B<sub>trigger</sub> and B<sub>lim</sub>; rules 2 and 4) have lower P(SSB< B<sub>lim</sub>) than the rules with a single biomass trigger point (B<sub>trigger</sub> only; rules 1 and 3).

In general, higher [F<sub>target</sub>, B<sub>trigger</sub>] or [HR<sub>target</sub>, B<sub>trigger</sub>] combinations give the highest yields, although the differences are small for options with P(SSB< B<sub>lim</sub>) less than 5%. When comparing the yields for the different rules in the medium term, a general pattern is that the yields are similar between F rules and biomass rules.

Increasing the  $F_{target}$ ,  $HR_{target}$ , or the  $B_{trigger}$  in the HCR leads to increased interannual variability in yield. The interannual variability in yield was generally lower for the biomass rules (rule 3 and 4) than for the F rules (rule 1 and 2), and also generally lower for the average TAC constraint than for the +25%/-20% TAC constraint. The lowest interannual variability was found for the biomass rule (rule 3) when an average constraint was included.

During this evaluation it became apparent that the fishing mortality reference points published in April (ICES, 2018a) were estimated incorrectly. These were re-estimated;  $F_{MSY}$  was revised from 0.108 to 0.157,  $F_{Pa}$  was revised from 0.182 to 0.227, and  $F_{lim}$  was revised from 0.234 to 0.291. There was not enough time to evaluate the effect of allowing a maximum of 10% of the TAC to be banked or borrowed any year.

### Request

# Request to ICES concerning a long-term management strategy for Norwegian spring-spawning herring

In order to revise the long-term management plan for Norwegian spring-spawning herring consistent with the new stock assessment model (ICES 2016; 2017) and the corresponding updated reference points (ICES 2018a; 2018b), a Management Strategy Evaluation is needed. The objective is to ensure harvest of the stock within safe biological limits. The Parties therefore request ICES to evaluate the following harvest control rules.

Rule 1

- A range of B<sub>trigger</sub> from 1 to 6 million tonnes with a range of target Fs from 0.05 to 0.25.
- The fishing mortality is the average for age groups 5 to 12+ weighted by stock numbers.
- Time of comparison for SSB is the same as used in the assessment.

<sup>&</sup>lt;sup>‡</sup>The harvest control rule selected by the Coastal States was initially not evaluated for robustness to the inclusion of TAC constraints and banking and borrowing by WKNSSHMSE. Following the Coastal States agreement for the long-term management strategy, which included TAC constraints (-20% to +25%) and 10% banking or borrowing, additional simulations were run to evaluate these additions to the HCR (Annex 9 in ICES, 2018c).

- A harvest control rule with a fishing mortality equal to the target F when SSB is at or above B<sub>trigger</sub>.
- In the case that the SSB is forecast to be less than B<sub>trigger</sub>, the TAC shall be fixed consistently with a fishing mortality that is given by:
- F = Ftarget\*SSB/Btrigger
   The following special case is to be evaluated: Btrigger=3.184 (=MSY Btrigger=Bpa) and the target fishing mortality of 0.102 (F<sub>MSY</sub>).

Rule 2

- A range of B<sub>trigger</sub> from 2.5 to 6 million tonnes with a range of target Fs from 0.05 to 0.25.
- The fishing mortality is the average for age groups 5 to 12+ weighted by stock numbers.
- Time of comparison for SSB is the same as used in the assessment.
- A harvest control rule with a fishing mortality equal to the target F when SSB is at or above B<sub>trigger</sub>.
- In the case that the SSB is forecast to be less than Blim, the target F is 0.05.
- In the case that the SSB is forecast to be between B<sub>lim</sub> and B<sub>trigger</sub>, the target F will decrease linearly between those two points.
- The following special case is to be evaluated: B<sub>trigger</sub>=3.184 (=MSY B<sub>trigger</sub>=B<sub>pa</sub>) and the target fishing mortality of 0.102 (F<sub>MSY</sub>).

# Rule 3

- A proxy for SSB (SSB<sub>proxy</sub>) is defined as the biomass of herring aged 5 and older or an appropriate age range as identified by ICES.
- The reference biomass (B<sub>ref</sub>) is defined as the biomass of herring aged 4 and older or an appropriate age range as identified by ICES.
- Time of comparison for SSB<sub>proxy</sub> is the same as used for SSB in the assessment.
- A range of B<sub>trigger</sub> from 1 to 6 million tonnes with an approriate range of harvest rate (HR<sub>target</sub>).
- A harvest control rule with TAC=HR<sub>target</sub>\*B<sub>ref</sub> when SSB<sub>proxy</sub> is at or above B<sub>trigger</sub>.
- In the case that the SSB<sub>proxy</sub> is forecast to be less than B<sub>trigger</sub>, the TAC = HR<sub>target</sub>\* B<sub>ref</sub> \* (SSB<sub>proxy</sub>/B<sub>trigger</sub>)
- The following special case is to be evaluated: Btrigger=3.184 (=MSY B<sub>trigger</sub>=B<sub>pa</sub>) and a harvest rate equivalent to 0.102 (F<sub>MSY</sub>).

# Rule 4

A biomass rule intended to be equivalent to Rule 2 with two levels of harvest rate: target harvest rate =  $HR_{target}$  when  $SSB_{proxy}$  is greater than  $B_{trigger}$ ; harvest rate =  $HR_{lowest}$  when  $SSB_{proxy}$  is below  $B_{lim}$ ; and harvest rate decreasing linearly between these bounds.

# Evaluation and performance criteria

Starting point of the evaluations should be the current stock status as estimated by the most recent assessment and be consistent across time.

Each alternative shall be assessed in relation to how it performs in the short term (2019-2023), medium term (2024-2033) and long term (2034-2053) in relation to:

- Average SSB
- Average yield
- Indicator for year to year variability in SSB and yield
- Risk of SSB falling below Blim

# Evaluation of the management strategies shall be simulated:

- With no constraint on the interannual variation of TAC.
- With a constraint on the interannual variation of TAC:
  - When the rules would lead to a TAC, which deviates by more than 20% below or 25% above the TAC of the preceding year, the TAC is to be set respectively no more than 20% less or 25% more than the TAC of the preceding year.
  - The TAC is to be set as the average of a) the current TAC and b) the TAC that would result from the application of the harvest control rule without constraint for the TAC year.

- The TAC constraint shall not apply if the SSB (rule 1 and 2) or SSB<sub>proxy</sub> (rule 3 and 4) in the year for which the TAC is to be set is less or equal to Btrigger.
- Allowing a maximum of 10% to be banked or borrowed any year.

*ICES is also requested to assess what, if any, other measures in addition to those contained in the present Management Strategy might contribute to attaining the objectives of the strategy, and provide estimates of their efficiency.* 

Finally, it is expected that the Parties will, as appropriate, review and revise these management measures and strategies on the basis of any new advice provided by ICES.

# Elaboration on the advice

# Evaluation of the fishing mortality reference points

During these evaluations, two changes were made which impacted on the estimates of fishing mortality reference points. Ages 0–1 were included in the analysis and the number of iterations in the simulation model were increased to improve the stability of the estimates. These changes had a minor impact on the biomass reference points, which were kept unchanged, but fishing mortality reference points were different.

The estimation of fishing mortality reference points is sensitive to inputs and assumptions. The current management plan target of 0.125 has been used for nearly two decades without driving the stock below  $B_{lim}$ . The current analysis confirms that this fishing mortality is precautionary since it is below  $F_{MSY}$  (=  $F_{p05}$ ).

# Evaluation of the four rules suggested for long-term management strategy

The target fishing mortality values evaluated are in the range of 0.10 to 0.20. These were used in combination with  $B_{trigger}$  values in the range of 2.5–5 million tonnes, including MSY  $B_{trigger}$  = 3.184 million t. The target harvest rate values evaluated range from 0.07 to 0.15. Comparing short-, medium-, and long-term tables for the HCRs without a constraint on the interannual variation of the TAC, a main result is that, for any given [ $F_{target}$ ,  $B_{trigger}$ ] or [ $HR_{target}$ ,  $B_{trigger}$ ] combination, the P(SSB<  $B_{lim}$ ) is highest in the medium term (Tables 3 and 4). This is as expected, given the current low stock size.

For rule 1 (where F is reduced linearly below the biomass target),  $F_{target}$  values around 0.15 to 0.18 combined with  $B_{trigger}$  values around 4.0 to 5.0 million t resulted in the highest median long-term yield (Table 5). Similar results were found for the medium term, although yield is generally lower in the medium term than in the long term. In the short term, the median yield is even lower because of the current low stock size. The highest yields were found at  $F_{target}$  values around 0.125 to 0.17 combined with  $B_{trigger}$  values around 3.5 to 5 million t.

For rule 2 (where F is reduced to 0.05 below B<sub>lim</sub> and reduced linearly below the biomass target), a higher number of [ $F_{target}$ ,  $B_{trigger}$ ] combinations were found precautionary compared to rule 1, likely because rule 2 has a steeper reduction in F below  $B_{trigger}$ . For rule 2, the highest median long-term yields were at  $F_{target}$  values around 0.17 to 0.20 combined with  $B_{trigger}$  values around 4.0 to 5 million t (Table 5). In the medium term, the highest median yields were found at  $F_{target}$  values around 0.18 to 0.20 combined with  $B_{trigger}$  values around 4 to 5 million t. In the short term, the highest median yields were found at  $F_{target}$  values around 0.16 to 0.20 combined with  $B_{trigger}$  values around 3.5 to 4 million t.

For rule 3 (the biomass rule, with a linear decline in harvest rate),  $HR_{target}$  values around 0.12 to 0.14 in combination with  $B_{trigger}$  values around 4.5 to 5 million t resulted in the highest median long-term yields. In the medium term this was achieved at  $HR_{target}$  values around 0.12 to 0.13 combined with  $B_{trigger}$  values around 4.5 to 5 million t (Table 6). The short-term median yield was highest with combinations of  $HR_{target}$  values around 0.12 to 0.13 and  $B_{trigger}$  values around 4.5 to 5 million t.

Similar to the F rules (rules 1 and 2) the biomass rule, with two changes in harvest rate (rule 4), had a higher number of precautionary combinations compared to rule 3. The highest median long-term yields for rule 4 were found at  $HR_{target}$  values around 0.13 to 0.15 combined with  $B_{trigger}$  values around 4 to 5 million t (Table 6). In the medium term the highest median yield was achieved at  $HR_{target}$  values around 0.14 to 0.15 combined with  $B_{trigger}$  values around 4.5 to 5 million t. In the short term the highest median yield was achieved at  $HR_{target}$  values around 0.11 to 0.13 combined with  $B_{trigger}$  values around 3.5 to 4 million t.

Increasing the  $F_{target}$ ,  $HR_{target}$ , or the  $B_{trigger}$  in the HCR leads to increased interannual variability (IAV, defined here as % change between any two consecutive years) in yield. When no constraint on TAC variation is included in the F rules, the interannual variability ranges from about 17% for [low  $F_{target}$ , low  $B_{trigger}$ ] combinations to about 30% for [high  $F_{target}$ , high  $B_{trigger}$ ] precautionary combinations (Table 7). When a TAC constraint based on an average TAC is included, the range is approximately 9–17%, and when a +25%/–20% TAC constraint is included the range is 19–21%. For the biomass rules (Table 8), the variability for rules without TAC constraint varied between 9% and 16%, for an averaging TAC constraint the variability was 7%–12%, and for the +25%/–20% TAC constraint the variability was 10–16%. Implementation of the TAC constraint for rules 1 and 3 had minor impact in terms of average yield.

It is important to note that [high  $F_{target}$ , high  $B_{trigger}$ ] combinations result in actual Fs that can, on average, be substantially lower than the target F (Table 9). This is because the F used to set the catch according to the HCR is reduced below the  $F_{target}$  whenever the SSB is forecasted to be below  $B_{trigger}$ . So rules with higher target F do not necessarily result in overall higher Fs in reality, but will result in higher interannual changes in both F and yield.

For any given  $[F_{target}, B_{trigger}]$  or  $[HR_{target}, B_{trigger}]$  combination, the interannual yield variability range widens considerably with increases in either the  $F_{target}$ ,  $HR_{target}$ , or the  $B_{trigger}$ . In such cases interannual yield variability values that are much higher than the medians reported in the tables cannot be ruled out (Figure 2).

Precautionary [ $F_{target}$ ,  $B_{trigger}$ ] combinations were identified (Table 1). There is a set of "borderline" combinations, corresponding to the 5% risk (i.e. probability of SSB falling below  $B_{lim}$ ), in which larger values of  $F_{target}$  are associated with larger values of  $B_{trigger}$  (for the same 5% risk) and vice versa. The precautionary  $F_{target}$  values associated with the lowest and the highest  $B_{trigger}$  values and with MSY  $B_{trigger}$  are shown in Table 1.

Table 1Maximum precautionary Ftarget(≤ 5% risk) under the lowest, highest, and MSY Btrigger values for rule 1 in the medium<br/>term.

	B <sub>trigger</sub> = 2.5 million t	B <sub>trigger</sub> = 5 million t	B <sub>trigger</sub> = MSY B <sub>trigger</sub> = 3.184 million t
No TAC change constraint	0.10	0.17	0.10
Average TAC constraint	0.10	0.17	0.12
+25%/-20% TAC constraint	0.10	0.17	0.12

There was not enough time to evaluate the last point in the request: to test the effect of allowing a maximum of 10% to be banked or borrowed any year.

# Evaluation of the long-term management strategy chosen by the Coastal States<sup>§</sup>

The harvest control rule selected by the Coastal States was initially not evaluated for precautionarity to TAC constraints and banking and borrowing by WKNSSHMSE. Following the Coastal States agreement for the long-term management strategy, additional simulations were run to evaluate the LTMS. The results indicate that the LTMS is consistent with the precautionary approach (the maximum annual probability of SSB being below B<sub>lim</sub> is less than 5% in any of the years simulated). In addition, the HCR remains precautionary when constraints on interannual TAC change and 10% banking or borrowing of quota between years are added. Full results are presented in Annex 2.

# Basis of the advice

# Background

The Norwegian spring-spawning herring (NSSH) was benchmarked in 2016 (ICES, 2016) and XSAM was accepted as the assessment model for this stock. The reference points were reevaluated in 2018 (ICES, 2018a). ICES advised that the current B<sub>lim</sub> value of 2.5 million tonnes for the Norwegian spring-spawning herring (NSSH) should be retained while B<sub>pa</sub> and MSY B<sub>trigger</sub> should be revised to 3.184 million tonnes. ICES furthermore advised that F<sub>MSY</sub> should be set to 0.102, with F<sub>lim</sub> being revised to 0.234 and F<sub>pa</sub> revised to 0.182.

<sup>&</sup>lt;sup>§</sup> Version 2: Section added.

In May 2018 NEAFC sent a request to ICES for an evaluation of a range of harvest control rules that could form the basis for a long-term management strategy for the stock. This request was dealt with by WKNSSHMSE (ICES Workshop on management strategy evaluation for the Norwegian spring spawning herring in subareas 1, 2 and 5, and in divisions 4.a and 14.a), meeting in 26–27 August 2018, and also working by correspondence (ICES, 2018c).

During WKNSSHMSE, because of issues related to the historical time-series of SSB/R pairs, the fishing mortality reference points established earlier in 2018 (ICES, 2018a) were revised, as explained above.

## **Results and conclusions**

Results and conclusions are detailed in the elaboration on the advice section above, and in Annex 1.

In the present evaluation, the assessment was assumed to be unbiased, which may not be the case. A sensitivity analysis was carried out assuming 10% and 15% bias. This bias increased the probability of SSB falling below  $B_{lim}$ ; however, the actual level of bias is currently unknown.

### Methods

The simulations done are based on the assessment model (XSAM) used in ICES to conduct annual assessments for this stock. In the assessment, the model is run for ages 2-12+ and for the years 1988 to present (ICES, 2018d).

The effect on the simulation output of the variability in biological parameters (weights and proportion fish mature-at-age) has been evaluated for the F rules and found to be very small relative to the effect of the very high variability in recruitment. Therefore, long-term unweighted means (1988–2017) were used for the future mean weights-at-age and proportion mature-at-age in the simulations.

The recruitment model was a combination of the Beverton–Holt, Ricker, and segmented regression stock and recruitment functions.

The variation of the selection pattern in the simulation were generated using the same time-series model as in the assessment.

To establish the basis for MSE, the model is run from 1950 to present to obtain a sufficiently long time-series to estimate an appropriate stock-recruitment relationship. The assessment provides the approximated simultaneous distribution of all parameters and stock sizes such that initial values can be sampled from this approximated distribution. The catch in 2018 is set as the quota for 2018. For 2019 onwards catches are given by the proposed management strategies tested.

One replicate is obtained as follows: Sample one realization of stock sizes-at-age for 1st January 2018 from the assessment made in 2017 and parameters specifying the model for fishing mortality from their simultaneous distribution. Sample one set of parameters for the spawning-stock recruitment model independently from stock sizes. For one set of initial values, parameters for F, and parameters for spawning-stock recruitment, the stock is projected forward for a given management strategy using assessment and prediction errors until 2053. The performance statistics as a function of sample size (number of replicates) were found to have stabilized after 3000 replicates.

# Sources and references

ICES. 2016. Report of the Benchmark Workshop on Pelagic Stocks (WKPELA), 29 February–4 March 2016, ICES Headquarters, Copenhagen, Denmark. ICES CM 2016/ACOM:34. 106 pp.

ICES. 2017. Report of the Working Group on Widely Distributed Stocks (WGWIDE), 30 August–5 September 2017, ICES Headquarters, Copenhagen, Denmark. ICES CM 2017/ACOM:23. 994 pp.

ICES. 2018a. Report of the Workshop on the determination of reference points for Norwegian Spring Spawning herring (WKNSSHREF), 10–11 April 2018, ICES Headquarters, Copenhagen, Denmark. ICES CM 2018/ACOM:45. 83 pp.

ICES. 2018b. Coastal States request for ICES to re-evaluate the reference points for Norwegian spring-spawning herring. *In* Report of ICES Advisory Committee, 2018. ICES Advice 2018, sr.2018.06. Issued 26 April 2018.

ICES. 2018c. Report of the Workshop on a long-term management strategy for Norwegian Spring-spawning herring (WKNSSHMSE), 26-27 August 2018, Torshavn, Faroe Islands. ICES CM 2018/ACOM:53. 113pp. ICES. 2018d. Report of the Working Group on Widely Distributed Stocks (WGWIDE), 28 August–3 September 2018, Torshavn, Faroe Islands. ICES CM 2018/ACOM: 23. 488 pp.

# Annex 1

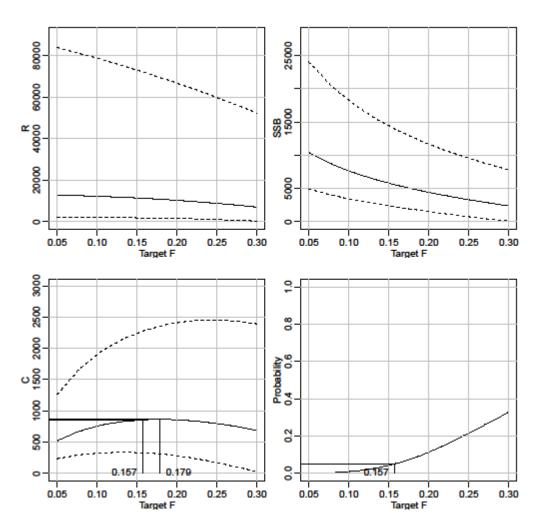


Figure 1Median recruitment, SSB, and catch when fishing with constant target F without MSY Btrigger, including prediction error,<br/>and the probability of falling below Blim in any year using the MSY approach with MSY Btrigger = Bpa (lower right panel).<br/>The corresponding 5th and 95th percentiles are shown with dashed lines. The FMSY point and the Fp05 value are<br/>indicated with vertical lines.

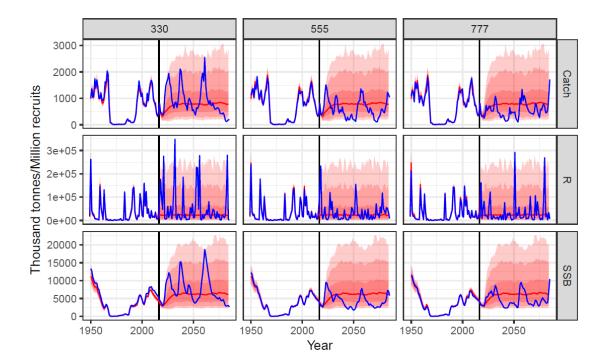


Figure 2Simulation results for 2019–2053 together with the historical assessment, for Rule 1 (Btrigger = 3184 thousand tonnes,<br/>Ftarget = 0.125). The three rows correspond to the realised catch, recruitment, and SSB, and show the 5th, 25th, 50th,<br/>75th, and 95th percentiles of their distribution. The columns correspond to three particular realisations (numbered on<br/>top, selected semi-randomly).

Risk, with P(SSB<  $B_{lim}$ ), expressed as % in the short, medium, and long term for F rules without and with constraint in interannual TAC change. Unshaded cells correspond to the precautionary [ $F_{target}$ ,  $B_{trigger}$ ] combinations [P(SSB<  $B_{lim}$ )< 5%].

# **Risk3 tables for F-rules**

Shortterm risk         FLarget           0.1         0.102         0.12         0.12         0.12         0.12         0.13         0.15         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.12         0.16         0.17         0.16         0.17         0.16         0.12         0.16         0.17         0.16         0.17         0.16         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16	mediumterm risk Ftarget	longterm risk Ftarget						
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3184 3.2 3.4 5.3 5.7 7.1 8.2 8.9 9.3 10.8 12.0 15.4	3184 3.3 3.5 5.2 5.8 7.5 8.9 9.7 10.2 11.4 12.9 16.2	3184 2.0 2.1 3.4 4.0 5.4 6.3 7.3 7.7 9.0 10.7 13.8						
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b         3500         2.7         2.9         4.5         4.9         6.3         7.3         7.9         8.1         9.2         10.4         13.2           2         4000         2.1         2.2         3.0         3.5         4.8         5.6         6.3         6.6         7.4         8.2         10.2	0	0						
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b         3500         2.6         2.8         4.2         4.7         5.9         6.7         7.4         7.7         8.6         9.7         12.1           #         #         #         #         #         5.5         6.1         6.4         7.1         8.0         9.9	b         3500         2.7         2.9         4.3         4.7         6.3         7.1         8.0         8.3         9.5         10.8         13.4           b         4000         2.3         2.3         3.2         3.6         5.0         5.9         6.5         6.7         7.7         8.8         11.0	0         3500         1.6         1.7         2.8         3.2         4.4         5.3         6.1         6.4         7.6         9.1         11.8           4000         1.3         1.4         2.2         2.5         3.5         4.2         4.7         4.8         5.9         6.8         9.7						
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5000 1.6 1.6 2.0 2.1 2.7 3.0 3.6 3.9 4.5 5.1 6.7	5000 1.3 1.4 2.0 2.3 3.0 3.4 3.9 4.0 4.8 5.6 7.1	5000 0.9 0.9 1.3 1.4 1.9 2.4 2.8 3.0 3.6 4.2 5.4						
ि shortterm risk ह	mediumterm risk Ftarget	longterm risk Ftarget						
shortterm risk 55 61 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.16 0.2 61 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.16 0.2	Ftarget 0.1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.18 0.2	Ftarget 0.1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.18 0.2						
shortterm risk 5 5 5 5 5 5 5 5 5 5 5 5 5	Ftarget           0.1         0.102         0.12         0.125         0.14         0.15         0.16         0.17         0.16         0.2           2500         4.1         4.3         6.2         6.7         8.9         10.2         11.2         11.5         13.0         14.5         17.5	0.1         0.102         0.12         0.125         0.14         0.15         0.157         0.16         0.17         0.18         0.2           2500         2.4         2.6         4.4         5.0         6.5         7.7         8.7         9.1         10.8         12.3         16.0						
shortterm risk 1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.16 0.2 2500 4.3 4.5 6.2 6.7 8.4 9.9 10.6 10.9 12.2 13.6 15.7 3184 3.1 3.3 5.1 5.6 6.9 7.7 8.4 8.6 9.6 11.1 13.1	Frarget           0.1         0.102         0.12         0.125         0.14         0.15         0.157         0.16         0.17         0.16         0.2           2500         4.1         4.3         6.2         6.7         8.9         10.2         11.2         11.5         13.0         14.5         17.5           3164         3.3         3.4         4.9         5.4         7.0         8.2         9.0         9.3         10.6         11.7         14.5	Ftarget 1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.16 0.2 2500 2.4 2.6 4.4 5.0 6.5 7.7 8.7 9.1 10.8 12.3 16.0 3184 1.7 1.9 3.1 3.6 5.1 6.0 6.8 7.1 8.5 9.8 12.8						
Shortterm risk         Flarget           Shortterm risk         Flarget           0.1         0.102         0.12         0.125         0.14         0.15         0.157         0.16         0.07         0.16         10.9         12.2         13.6         15.7           2500         4.3         4.5         6.2         6.7         8.4         9.9         10.6         10.9         12.2         13.6         15.7           3184         3.1         3.3         5.1         5.6         6.9         7.7         8.4         8.6         9.6         11.1         13.1           300         2.7         2.8         4.4         4.8         6.1         6.8         7.4         7.7         8.5         9.5         11.8	Frarget           0.1         0.102         0.12         0.125         0.14         0.15         0.157         0.16         0.17         0.16         0.2           2500         4.1         4.3         6.2         6.7         8.9         10.2         11.2         11.5         13.0         14.5         17.5           3164         3.3         3.4         4.9         5.4         7.0         8.2         9.0         9.3         10.6         11.7         14.5	Ftarget 1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.16 0.2 2500 2.4 2.6 4.4 5.0 6.5 7.7 8.7 9.1 10.8 12.3 16.0 3184 1.7 1.9 3.1 3.6 5.1 6.0 6.8 7.1 8.5 9.8 12.8						
Shortterm risk         Ftarget           010         0.102         0.125         0.14         0.157         0.16         0.17         0.16         0.17           010         4.3         4.5         6.2         6.7         8.4         9.9         10.6         10.9         12.2         13.6         15.7           3184         3.1         3.3         5.1         5.6         6.9         7.7         8.4         8.6         9.6         11.1         13.1           000         2.7         2.8         4.4         4.8         6.1         6.8         7.4         7.7         8.5         9.5         11.8           0100         2.1         2.2         3.0         3.4         4.7         5.5         6.1         6.3         7.1         7.9         9.8	Frarget           0.1         0.102         0.12         0.125         0.14         0.15         0.157         0.16         0.17         0.16         0.2           2500         4.1         4.3         6.2         6.7         8.9         10.2         11.2         11.5         13.0         14.5         17.5           3164         3.3         3.4         4.9         5.4         7.0         8.2         9.0         9.3         10.6         11.7         14.5	Ftarget 1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.16 0.2 2500 2.4 2.6 4.4 5.0 6.5 7.7 8.7 9.1 10.8 12.3 16.0 3184 1.7 1.9 3.1 3.6 5.1 6.0 6.8 7.1 8.5 9.8 12.8						
Shortterm risk         Ftarget           0.1         0.102         0.12         0.12         0.14         0.15         0.16         0.17         0.16         0.17           0.0         4.3         4.5         6.2         6.7         8.4         9.9         10.5         10.9         12.2         13.6         15.7           0.0         0.27         2.8         4.4         4.8         6.1         6.8         7.7         8.5         9.5         11.8           0.00         0.27         2.8         4.4         4.8         6.1         6.8         7.4         7.7         8.5         9.5         11.8           0.00         0.27         2.8         4.4         4.8         6.1         6.8         7.4         7.7         8.5         9.5         11.8           0.00         0.01         0.21         2.2         3.0         3.4         4.7         5.5         6.1         6.3         7.1         7.9         9.8           0.00         0.01         0.18         2.5         2.7         3.5         4.4         8.4         9.5         6.5         7.9	Farget           Farget           0.1         0.102         0.12         0.125         0.14         0.15         0.157         0.16         0.17         0.16         0.2           2500         4.1         4.3         6.2         6.7         8.9         10.2         11.2         11.5         13.0         14.5         17.5           3184         3.3         3.4         4.9         5.4         7.0         8.2         9.0         9.3         10.6         11.7         14.5           50         3500         2.7         2.9         4.3         4.7         6.2         7.1         7.9         8.2         9.4         10.5         12.8	Flarget         Fraget         Fradet         Fradet         Fradet						
Flarget           Flarget           1         0.12         0.12         0.12         0.12         0.12         0.12         0.15         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.11         0.11         0.11         0.11         0.16         0.17 <th 0"0<="" colspan="6" td="" th<=""><td>Farget           Farget           Farget           1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.16 0.2           2500         4.1         4.3         6.2         6.7         8.9         10.2         11.2         11.5         13.0         14.5         17.5           314         3.3         3.4         4.9         5.4         7.0         8.2         9.0         9.3         10.6         11.7         14.5           3000         2.7         2.9         4.3         4.7         6.2         7.1         7.9         8.2         9.4         10.5         12.8           4         3.3         3.2         3.7         4.9         5.8         6.4         6.6         7.6         8.6         10.8</td><td>I         0.1         0.12         0.125         0.14         0.15         0.15         0.17         0.16         0.2           250         2.4         2.6         4.4         5.0         6.5         7.7         8.7         9.1         1.0.8         12.3         16.0           3144         1.7         1.9         3.1         3.6         5.1         6.0         6.8         7.1         8.5         9.8         12.8           3000         1.5         1.6         2.7         3.1         4.2         5.2         5.8         6.1         7.2         8.5         11.3           44000         1.3         1.4         2.2         2.4         3.3         4.0         4.5         4.7         5.4         6.6         8.9</td></th>	<td>Farget           Farget           Farget           1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.16 0.2           2500         4.1         4.3         6.2         6.7         8.9         10.2         11.2         11.5         13.0         14.5         17.5           314         3.3         3.4         4.9         5.4         7.0         8.2         9.0         9.3         10.6         11.7         14.5           3000         2.7         2.9         4.3         4.7         6.2         7.1         7.9         8.2         9.4         10.5         12.8           4         3.3         3.2         3.7         4.9         5.8         6.4         6.6         7.6         8.6         10.8</td> <td>I         0.1         0.12         0.125         0.14         0.15         0.15         0.17         0.16         0.2           250         2.4         2.6         4.4         5.0         6.5         7.7         8.7         9.1         1.0.8         12.3         16.0           3144         1.7         1.9         3.1         3.6         5.1         6.0         6.8         7.1         8.5         9.8         12.8           3000         1.5         1.6         2.7         3.1         4.2         5.2         5.8         6.1         7.2         8.5         11.3           44000         1.3         1.4         2.2         2.4         3.3         4.0         4.5         4.7         5.4         6.6         8.9</td>						Farget           Farget           Farget           1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.16 0.2           2500         4.1         4.3         6.2         6.7         8.9         10.2         11.2         11.5         13.0         14.5         17.5           314         3.3         3.4         4.9         5.4         7.0         8.2         9.0         9.3         10.6         11.7         14.5           3000         2.7         2.9         4.3         4.7         6.2         7.1         7.9         8.2         9.4         10.5         12.8           4         3.3         3.2         3.7         4.9         5.8         6.4         6.6         7.6         8.6         10.8	I         0.1         0.12         0.125         0.14         0.15         0.15         0.17         0.16         0.2           250         2.4         2.6         4.4         5.0         6.5         7.7         8.7         9.1         1.0.8         12.3         16.0           3144         1.7         1.9         3.1         3.6         5.1         6.0         6.8         7.1         8.5         9.8         12.8           3000         1.5         1.6         2.7         3.1         4.2         5.2         5.8         6.1         7.2         8.5         11.3           44000         1.3         1.4         2.2         2.4         3.3         4.0         4.5         4.7         5.4         6.6         8.9
	Farget           Farget           Farget           10.1 0.102 0.12 0.125 0.157 0.15 0.17 0.16 0.17 0.16 0.2           2500         4.1         4.3         6.2         6.7         8.9         10.2         11.2         11.5         13.0         14.5         17.5           3144         3.3         3.4         4.9         5.4         7.0         8.2         9.0         9.3         10.6         11.7         14.5           3000         2.7         2.9         4.3         4.7         6.2         7.1         7.9         8.2         9.4         10.5         12.8           4000         2.3         2.3         3.2         3.7         4.9         5.8         6.4         6.6         7.6         8.6         10.8           4500         1.6         1.7         2.5         2.8         3.7         4.5         5.0         5.2         6.1         7.0         8.7	Bit         0.1         0.12         0.125         0.14         0.15         0.15         0.17         0.16         0.2           250         2.4         2.6         4.4         5.0         6.5         7.7         8.7         9.1         1.0.8         12.3         16.0           3164         1.7         1.9         3.1         3.6         5.1         6.0         6.8         7.1         8.5         9.8         12.8           3930         1.5         1.6         2.7         3.1         4.2         5.2         5.8         6.1         7.2         8.5         11.3           4000         1.3         1.4         2.2         2.4         3.3         4.0         4.5         4.7         5.4         6.6         8.9           4500         1.1         1.1         1.5         1.7         2.5         3.2         3.6         3.7         4.5         5.0         6.9						
5000 1.6 1.6 2.0 2.1 2.7 3.0 3.6 3.9 4.5 5.1 6.7 shortterm risk	Fraget           Fraget           Fraget           Fraget           1         102         0.12         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         1.5	Flarget           Fraget           Fraget           Fraget           Fraget           Fraget           Fraget           Fraget           1.0.102         0.12         0.15         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.1         0.16         0.1         0.16         0.1         0.16         0.1         0.16         0.1         0.16         0.1         0.1         0.1         0.1         0.16						
5000 1.6 1.6 2.0 2.1 2.7 3.0 3.6 3.9 4.5 5.1 6.7 shortterm risk	Frarget         Frarget         Frarget         2000       1.1       0.102       0.12       0.15       0.15       0.15       0.15       0.15       0.15       0.15       0.15       0.15       0.15       0.15       1.1       5       1.5       <	Fraget         Fraget         Fraget         Fraget         1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.16 0.2         2400       2.4       2.6       4.4       5.0       6.5       7.7       8.7       9.1       1.0.8       12.3       16.0         3184       1.7       1.9       3.1       3.6       5.1       6.0       6.8       7.1       8.5       9.8       12.8         3000       1.5       1.6       2.7       3.1       4.2       5.2       5.8       6.1       7.2       8.5       11.3         4000       1.3       1.4       2.2       2.4       3.3       4.0       4.5       4.7       5.4       6.6       8.9         4500       1.1       1.1       1.5       1.7       2.5       3.2       3.6       3.7       4.5       5.0       6.9         5000       0.8       0.9       1.3       1.4       1.8       2.4       2.7       2.9       3.4       4.2       5.3         Iongterm risk       Ftarget						
5000 1.6 1.6 2.0 2.1 2.7 3.0 3.6 3.9 4.5 5.1 6.7 shortterm risk 5000 1.0 102 012 0125 0.14 015 0157 016 0.17 016 0.2 5000 0.0 102 012 0125 0.14 015 0.157 0.16 0.17 0.16 0.2	Frarget           Frarget           Frarget           Frarget           2500         4.1         4.3         6.2         6.7         8.9         10.2         11.2         1.5	Frarget           Frarget           Frarget           Frarget           Frarget           Frarget           10.10.2012 0.125 0.14 0.15 0.157 0.16 0.17 0.16 0.2           2500 2.4 2.6 4.4 5.0 6.5 7.7 8.7 9.1 10.8 12.3 16.0           3184           1.7         1.9         3.1         3.6 5.1         6.0         6.8 7.1         8.5 9.8 12.8           3050         1.5         1.6         2.7         3.1         4.2 5.2         5.8 6.1         7.2 8.5 11.3           4000         1.3         1.4         2.2 2.4         3.3 4.0         4.5 4.7         5.4 6.8 8.9           4000         1.3         1.4         2.7 2.5         3.2         3.6 3.7         4.5 5.0         6.9           5000         0.8         0.9         1.3         1.4         8.2 4         2.7         2.9         3.4 4.2         5.3           Independent           Transform           Transform           Transform           Transform           Transform           Transform <th colspan="6" td="" tran<=""></th>						
5000 1.6 1.6 2.0 2.1 2.7 3.0 3.6 3.9 4.5 5.1 6.7 shortterm risk 5000 1.0 102 012 0125 0.14 015 0157 016 0.17 016 0.2 5000 0.0 102 012 0125 0.14 015 0.157 0.16 0.17 0.16 0.2	Frarget           Frarget           Frarget           Frarget           2500         4.1         4.3         6.2         6.7         8.9         010.2         11.2         11.5         13.0         4.5         17.5           3184         3.3         3.4         4.9         5.4         7.0         8.2         9.0         9.3         10.6         11.7         14.5         17.5           3184         3.3         3.4         4.9         5.4         7.0         8.2         9.0         9.3         10.6         11.7         14.5         17.5           3184         3.3         3.4         4.9         5.4         7.0         8.2         9.0         9.3         10.6         11.7         14.5         17.5           4000         2.3         2.3         3.2         3.7         4.9         5.8         6.4         6.6         7.6         8.6         10.8           4500         1.6         1.7         2.5         2.8         3.7         4.5         5.0         5.2         6.1         7.0         8.7           5000         1.3         1.4         2.0	Frager           Frager           Frager           Frager           Frager           Frager           1         1         1         1         1         0           10         1.1         0.1         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.1         0.1         0.1         0.1         0.15         0.15         0.15         0.15         0.15         0.15         0.1         0.15         0.15         0.15         0.15         0.15         0.1         0.1         0.1 <th 0.0000000000000000000000000000000000<="" colspan="6" td=""></th>						
5000 1.6 1.6 2.0 2.1 2.7 3.0 3.6 3.9 4.5 5.1 6.7 shortterm risk 5000 1.0 102 012 0125 0.14 015 0157 016 0.17 016 0.2 5000 0.0 102 012 0125 0.14 015 0.157 0.16 0.17 0.16 0.2	Farget           Farget           Farget           2000         1.0         10.2         1.0         0.157         0.157         0.157         0.157         0.157         0.157         1.1 <th< td=""><td>Frager           Frager           Frager           Frager           1 0.102 0.12 0.125 0.14 0.15 0.15 0.16 0.17 0.16 0.2           10.10 0.12 0.125 0.14 0.15 0.15 0.16 0.17 0.16 0.2           3040           1.7         1.9         3.1         3.6         5.1         6.0         6.8         7.1         8.5         9.8         12.3         16.0           30400         1.5         1.6         2.7         3.1         4.2         2.5         5.8         6.1         7.2         8.5         9.8         12.8           30400         1.3         1.4         2.2         2.4         3.3         4.0         4.5         4.5         0.6         6.9           3040         1.3         1.4         2.2         2.4         3.7         3.4         4.2         5.3           3040         0.8         0.9         1.3         1.4         1.8         2.4         2.7         2.9         3.4         4.2         5.3           5000         0.8         0.9         1.3         1.4         1.8         2.4         2.7         2.9</td></th<>	Frager           Frager           Frager           Frager           1 0.102 0.12 0.125 0.14 0.15 0.15 0.16 0.17 0.16 0.2           10.10 0.12 0.125 0.14 0.15 0.15 0.16 0.17 0.16 0.2           3040           1.7         1.9         3.1         3.6         5.1         6.0         6.8         7.1         8.5         9.8         12.3         16.0           30400         1.5         1.6         2.7         3.1         4.2         2.5         5.8         6.1         7.2         8.5         9.8         12.8           30400         1.3         1.4         2.2         2.4         3.3         4.0         4.5         4.5         0.6         6.9           3040         1.3         1.4         2.2         2.4         3.7         3.4         4.2         5.3           3040         0.8         0.9         1.3         1.4         1.8         2.4         2.7         2.9         3.4         4.2         5.3           5000         0.8         0.9         1.3         1.4         1.8         2.4         2.7         2.9						
5000 1.6 1.6 2.0 2.1 2.7 3.0 3.6 3.9 4.5 5.1 6.7 shortterm risk 5000 1.0 102 012 0125 0.14 015 0157 016 0.17 016 0.2 5000 0.0 102 012 0125 0.14 015 0.157 0.16 0.17 0.16 0.2	Farget           Farget           Farget           2000         1.0         10.2         1.0         0.157         0.157         0.157         0.157         0.157         0.157         1.1 <th< td=""><td>Frager           Frager           Frager           Frager           1 0.102 0.12 0.125 0.14 0.15 0.15 0.16 0.17 0.16 0.2           10.10 0.12 0.125 0.14 0.15 0.15 0.16 0.17 0.16 0.2           3040           1.7         1.9         3.1         3.6         5.1         6.0         6.8         7.1         8.5         9.8         12.3         16.0           30400         1.5         1.6         2.7         3.1         4.2         2.5         5.8         6.1         7.2         8.5         9.8         12.8           30400         1.3         1.4         2.2         2.4         3.3         4.0         4.5         4.5         0.6         6.9           3040         1.3         1.4         2.2         2.4         3.7         3.4         4.2         5.3           3040         0.8         0.9         1.3         1.4         1.8         2.4         2.7         2.9         3.4         4.2         5.3           5000         0.8         0.9         1.3         1.4         1.8         2.4         2.7         2.9</td></th<>	Frager           Frager           Frager           Frager           1 0.102 0.12 0.125 0.14 0.15 0.15 0.16 0.17 0.16 0.2           10.10 0.12 0.125 0.14 0.15 0.15 0.16 0.17 0.16 0.2           3040           1.7         1.9         3.1         3.6         5.1         6.0         6.8         7.1         8.5         9.8         12.3         16.0           30400         1.5         1.6         2.7         3.1         4.2         2.5         5.8         6.1         7.2         8.5         9.8         12.8           30400         1.3         1.4         2.2         2.4         3.3         4.0         4.5         4.5         0.6         6.9           3040         1.3         1.4         2.2         2.4         3.7         3.4         4.2         5.3           3040         0.8         0.9         1.3         1.4         1.8         2.4         2.7         2.9         3.4         4.2         5.3           5000         0.8         0.9         1.3         1.4         1.8         2.4         2.7         2.9						
5000 1.6 1.6 2.0 2.1 2.7 3.0 3.6 3.9 4.5 5.1 6.7 shortterm risk 5000 1.0 102 012 0125 0.14 015 0157 016 0.17 016 0.2 5000 0.0 102 012 0125 0.14 015 0.157 0.16 0.17 0.16 0.2	Farget           Farget           Farget           2000         1.0         10.2         1.0         0.157         0.157         0.157         0.157         0.157         0.157         1.1 <th< td=""><td>Frager           Frager           Frager           Frager           1 0.102 0.12 0.125 0.14 0.15 0.15 0.16 0.17 0.16 0.2           10.10 0.12 0.125 0.14 0.15 0.15 0.16 0.17 0.16 0.2           3040           1.7         1.9         3.1         3.6         5.1         6.0         6.8         7.1         8.5         9.8         12.3         16.0           30400         1.5         1.6         2.7         3.1         4.2         2.5         5.8         6.1         7.2         8.5         9.8         12.8           30400         1.3         1.4         2.2         2.4         3.3         4.0         4.5         4.5         0.6         6.9           3040         1.3         1.4         2.2         2.4         3.7         3.4         4.2         5.3           3040         0.8         0.9         1.3         1.4         1.8         2.4         2.7         2.9         3.4         4.2         5.3           5000         0.8         0.9         1.3         1.4         1.8         2.4         2.7         2.9</td></th<>	Frager           Frager           Frager           Frager           1 0.102 0.12 0.125 0.14 0.15 0.15 0.16 0.17 0.16 0.2           10.10 0.12 0.125 0.14 0.15 0.15 0.16 0.17 0.16 0.2           3040           1.7         1.9         3.1         3.6         5.1         6.0         6.8         7.1         8.5         9.8         12.3         16.0           30400         1.5         1.6         2.7         3.1         4.2         2.5         5.8         6.1         7.2         8.5         9.8         12.8           30400         1.3         1.4         2.2         2.4         3.3         4.0         4.5         4.5         0.6         6.9           3040         1.3         1.4         2.2         2.4         3.7         3.4         4.2         5.3           3040         0.8         0.9         1.3         1.4         1.8         2.4         2.7         2.9         3.4         4.2         5.3           5000         0.8         0.9         1.3         1.4         1.8         2.4         2.7         2.9						
5000         1.6         1.6         2.0         2.1         2.7         3.0         3.6         3.9         4.5         5.1         6.7           shortterm risk         Ftarget           010         0.12         0.12         0.12         0.15         0.14         0.15         0.16         0.17         0.18         0.2           0.1         0.12         0.12         0.12         0.15         0.14         0.15         0.16         0.17         0.18         0.2           0.2500         3.2         3.4         5.0         5.5         6.7         7.7         8.3         8.6         9.1         10.9         13.3           3164         2.4         2.4         3.2         3.5         6.7         7.7         8.3         8.6         9.4         10.9         13.3           3164         2.4         2.4         3.5         6.2         6.8         8.1           4000         1.8         1.8         2.1         2.2         2.4         2.4         2.4         4.8         5.5         6.3         3.9           4500         1.6         1.8	Fraget           Fraget           1         10         11         11         1         1         5         17.5           318         3.3         3.4         4.9         5.4         7.0         8.2         9.0         9.3         10.5         12.8           4000         2.3         2.3         3.2         3.7         4.9         5.8         6.4         6.6         7.6         8.6         10.8           4000         2.3         2.3         3.2         3.7         4.5         5.0         5.2         6.1         7.0         8.7           5000         1.6         1.7         2.5         2.8         3.0         3.4         4.9         5.2         6.1         7.0         8.7           5000         3.3         3.4         4.9         5.2         7.0         8.2         8.9 <td< td=""><td>Flarget           Flarget           Flarget           Flarget           Flarget           Flarget           Flarget           Flarget           Flarget           Flarget           10         013 015 015 015 016 017 016 02           2.4         2.6         6.4.4         5.0         6.8         7.7         8.7         9.1         0.8         1.0         6.8         7.7         8.6         1         0.1           1.5         1.6         2.7         3.6         6.1         7.0         8.6         1           1.3         1.4         2.5         5.8         6.1         7.0         8.1         7.0           1.1         1.1         1.1         1.1         1.1         1.1           </td></td<>	Flarget           10         013 015 015 015 016 017 016 02           2.4         2.6         6.4.4         5.0         6.8         7.7         8.7         9.1         0.8         1.0         6.8         7.7         8.6         1         0.1           1.5         1.6         2.7         3.6         6.1         7.0         8.6         1           1.3         1.4         2.5         5.8         6.1         7.0         8.1         7.0           1.1         1.1         1.1         1.1         1.1         1.1						

Risk, with P(SSB<  $B_{lim}$ ), expressed as % in the short, medium, and long term for biomass rules without and with constraint in interannual TAC change. Unshaded cells correspond to the precautionary [ $F_{target}$ ,  $B_{trigger}$ ] combinations [P(SSB<  $B_{lim}$ )< 5%].

# Risk3 tables for biomass rules

Btrigger	:	shortt	erm ri	sk	н	Rtarg	et			
		0.07	80.0	0.09	0.1	0.11	0.12	0.13	0.14	0.15
2	2500	2.9	4.1	5.3	6.5	8.3	10.6	12.7	15.3	17.6
	3184	2.5	3.4	4.8	5.8	7.3	9.2	11.2	13.3	15.6
age	3500	2.2	2.9	4.1	5.1	6.2	7.8	10.0	11.7	13.7
Btrigger	4000	1.7	2.3	2.9	4.0	5.0	6.1	7.3	9.0	10.9
-	4500	1.6	1.8	2.3	2.9	3.7	4.9	5.5	6.5	8.0
				4.0	0.0	2.0	3.4	4.6	5.3	6.2
	5000	1.6	1.6	1.8	2.3	2.8	3.4	4.0	5.5	0.2
		shortt	erm ri	sk	н	Rtarg	et			
	1	shortt	erm ri: 0.08	sk 0.09	H 0.1	Rtarg	et 0.12	0.13	0.14	0.15
		shortt	erm ri	sk	н	Rtarg	et			
	2500	shortt	erm ri: 0.08	sk 0.09	H 0.1	Rtarg	et 0.12	0.13	0.14	0.15
	2500	shortt 0.07 4.0	erm ri: 0.08 4.9	sk 0.09 5.9	H 0.1 7.1	Rtarg 0.11 8.8	et 0.12 10.4	0.13 12.1	0.14 14.2	0.15 15.8
	2500	shortt 0.07 4.0 2.8	erm ri 0.08 4.9 3.9	sk 0.09 5.9 5.0	H 0.1 7.1 5.8	Rtarg 0.11 8.8 7.1	et 0.12 10.4 8.9	0.13 12.1 10.7	0.14 14.2 12.6	0.15 15.8 14.3
Btrigger	2500	0.07 4.0 2.8 2.3	erm ris 0.08 4.9 3.9 3.1	sk 0.09 5.9 5.0 4.2	H 0.1 7.1 5.8 5.1	Rtarg 0.11 8.8 7.1 6.1	et 0.12 10.4 8.9 7.5	0.13 12.1 10.7 9.4	0.14 14.2 12.6 11.3	0.15 15.8 14.3 12.9

	5	shortte	erm ri	sk	н	Rtarg	et			
		0.07	80.0	0.09	0.1	0.11	0.12	0.13	0.14	0.15
	2500	3.3	4.2	5.3	6.4	8.3	10.5	12.5	14.3	16.1
_	3184	2.5	3.5	4.8	5.7	7.2	9.1	11.0	12.6	14.3
Btrigger	3500	2.2	2.9	4.1	5.1	6.2	7.7	9.6	11.2	12.7
Ĩ	4000	1.7	2.3	2.9	4.0	5.0	6.0	7.1	8.7	10.5
-	4500	1.6	1.8	2.3	2.9	3.7	4.9	5.5	6.5	7.8
	5000	1.6	1.6	1.8	2.3	2.8	3.4	4.6	5.3	6.2

Rule 4 - biomass rule with HRmin = 0.05	\$	shortt	erm ri	sk	н	Rtarg	et			
Ë		0.07	80.0	0.09	0.1	0.11	0.12	0.13	0.14	0.15
HR.	2500	2.7	3.9	5.0	6.1	7.7	9.6	11.4	13.8	15.7
÷.	3184	2.2	3.1	3.9	4.8	5.7	6.8	8.4	9.9	12.0
ule v	Jaggina 3500 4000	2.2	2.6	3.2	4.1	4.8	5.7	6.5	7.8	9.2
355	15 4000	2.0	2.3	2.6	2.9	3.6	4.3	4.8	5.2	6.2
biom	4500	1.8	2.0	2.3	2.5	2.8	3.1	3.7	4.2	4.5
4	5000	1.8	1.9	2.1	2.3	2.5	2.7	2.9	3.2	3.7
Rula										

r	nediu	mterm	n risk	н	Rtarg	et			
	0.07	80.0	0.09	0.1	0.11	0.12	0.13	0.14	0.15
2500	2.8	3.7	5.0	6.6	8.6	10.8	12.8	15.2	18.0
3184	2.4	3.1	4.0	5.4	7.4	9.1	11.2	12.9	15.2
B 3500	2.0	2.7	3.6	4.7	6.0	7.8	9.8	11.6	13.3
Jaggina 3500	1.5	2.1	2.8	3.7	4.5	6.0	7.2	8.8	10.7
4500	1.1	1.5	2.1	2.8	3.6	4.3	5.6	6.8	8.1
5000	0.9	1.2	1.6	2.2	2.7	3.5	4.1	5.2	6.6

r	mediu	mterm	n risk	н	Rtarg	et			
	0.07	80.0	0.09	0.1	0.11	0.12	0.13	0.14	0.15
2500	3.4	4.3	5.5	7.1	9.0	10.9	12.7	14.6	16.7
_ 3184	2.7	3.2	4.2	5.5	7.4	9.0	10.7	12.4	14.5
Btrigger 4000	2.2	2.8	3.6	4.6	6.0	7.6	9.6	11.1	13.1
15 4000	1.5	2.2	2.8	3.7	4.4	6.0	7.2	8.8	10.5
4500	1.1	1.5	2.1	2.8	3.6	4.3	5.6	6.8	8.0
5000	0.9	1.2	1.6	2.1	2.7	3.5	4.1	5.1	6.5

	r	nediu	mterm	ı risk	н	Rtarg	et			
		0.07	80.0	0.09	0.1	0.11	0.12	0.13	0.14	0.15
	2500	2.9	3.8	5.1	6.6	8.5	10.7	12.6	14.5	16.9
_	3184	2.5	3.1	4.0	5.4	7.3	9.1	10.9	12.5	14.4
Btrigger	3500	2.1	2.7	3.5	4.6	5.9	7.8	9.7	11.1	12.9
Birio	4000	1.5	2.1	2.8	3.7	4.4	6.0	7.1	8.7	10.5
-	4500	1.1	1.5	2.1	2.8	3.6	4.2	5.5	6.8	8.0
	5000	0.9	1.2	1.6	2.1	2.7	3.5	4.1	5.1	6.5

r	nediu	mterm	n risk	н	Rtarg	et			
	0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15
2500	2.6	3.4	4.5	5.8	7.5	9.1	10.8	12.5	14.5
3184	2.2	2.7	3.3	4.2	5.3	6.3	7.9	8.9	10.1
Jaggina 3500	2.0	2.4	2.9	3.5	4.3	5.5	6.3	7.3	8.4
15 4000	1.6	2.1	2.4	2.9	3.4	3.8	4.7	5.7	6.6
4500	1.5	1.7	2.1	2.3	2.7	3.2	3.5	4.2	4.9
5000	1.4	1.6	1.7	2.1	2.3	2.6	3.0	3.4	3.9

1	ongte	rm ris	k	н	Rtarg	et			
	0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15
2500	1.4	2.0	3.1	4.4	6.0	7.7	10.0	12.1	14.8
3184	1.1	1.6	2.7	3.5	4.9	6.4	8.3	10.4	12.4
B 3500	1.0	1.4	2.3	3.1	4.2	5.6	7.2	9.1	11.2
Btrigger 4000	0.8	1.1	1.7	2.4	3.3	4.3	5.5	7.1	9.0
4500	0.6	1.0	1.3	1.8	2.6	3.2	4.2	5.2	6.7
5000	0.5	0.7	1.0	1.3	1.8	2.5	3.3	4.1	5.1

	longte	erm ris	k	н	Rtarg	et			
	0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15
2500	1.6	2.4	3.6	5.1	6.6	8.9	11.1	13.6	16.7
3184	1.2	1.9	2.8	3.9	5.3	6.9	9.3	11.4	13.7
1900 april 1900	1.1	1.6	2.4	3.4	4.5	5.9	8.0	9.9	12.1
11 4000	0.8	1.3	1.7	2.6	3.3	4.6	5.9	7.7	9.7
4500	0.6	1.0	1.3	1.9	2.6	3.4	4.4	5.8	7.3
5000	0.5	0.7	1.0	1.4	2.0	2.6	3.4	4.3	5.7

I	ongte	erm ris	k	н	HRtarget				
	0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15
2500	1.4	2.0	3.0	4.2	5.9	7.5	9.6	11.7	14.2
3184	1.1	1.6	2.6	3.5	4.6	6.3	7.9	10.1	12.0
Btrigger 4000	1.0	1.4	2.2	3.0	4.2	5.5	7.1	9.0	10.9
100 4000	0.8	1.1	1.7	2.3	3.2	4.3	5.5	6.9	8.9
4500	0.6	1.0	1.3	1.8	2.5	3.2	4.1	5.3	6.6
5000	0.5	0.7	1.0	1.3	1.8	2.5	3.2	4.0	5.1

1	ongte	rm ris	k	н	Rtarg	et			
	0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15
2500	1.2	1.8	2.7	3.6	4.6	6.0	7.6	9.1	10.8
3184	1.1	1.4	2.2	2.7	3.5	4.5	5.5	6.6	8.1
1900 rep	1.0	1.3	1.8	2.4	3.0	3.8	4.6	5.7	6.8
110 4000	1.0	1.1	1.4	1.9	2.4	3.0	3.6	4.2	5.3
4500	0.9	1.0	1.3	1.6	2.0	2.4	2.9	3.3	4.0
5000	0.8	1.0	1.2	1.4	1.6	2.1	2.4	2.7	3.0

Yield, expressed as median catch (kt), in the short, medium, and long term for F rules without and with a constraint in interannual TAC change. Red cells correspond to the non-precautionary [Ftarget, Btrigger] combinations [P(SSB< B<sub>lim</sub>)< 5%]. Cells shaded in green colours indicate the combinations that result in yield ≥95% of the maximum yield among the precautionary combinations.

# Yield tables for F-rules with Risk3

ੇ shortterm yield ਦੂ Ftarget	mediumterm yield Ftarget	longterm yield Ftarget		
Stoticiti yick         Ftarget           0         0.102         0.12         0.125         0.14         0.15         0.15         0.16         0.17         0           2500         381         387         442         456         499         527         545         553         578         6           2500         381         387         442         456         499         526         545         552         578         6				
루 3184 381 387 442 456 499 526 545 552 578 6				
3500         381         387         441         455         495         521         539         546         570         5           2         2         4000         365         370         418         430         466         488         503         509         531         5	0			
P H 4000 365 370 418 430 466 488 503 509 531 5				
	07         544         4500         592         598         657         671         710         733         747         752         769         782			
5000 307 311 353 364 396 416 430 436 454 4	72 507 5000 596 603 661 676 712 732 743 747 757 764	771         5000         717         724         778         790         824         843         854         859         871         879         880		
shortterm yield	mediumterm yield Ftarget	longterm yield Ftarget		
E Stortern Vield Ftarget 2500 377 382 424 435 468 491 506 512 533 5	.18 0.2 0.1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.18	0.2 0.1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.18 0.2		
8 2500 377 382 424 435 468 491 506 512 533 5	54         593         2500         579         586         644         659         700         723         739         745         765         782	815 2500 718 724 773 784 812 826 835 838 847 855 864		
8         3184         375         379         421         433         467         489         504         510         532         535           8         3500         371         376         419         431         465         488         503         510         531         5           9         8         4000         356         362         411         423 <b>458</b> 481         496         502         523         5				
b 555 555 557 571 576 419 431 465 488 503 510 531 5 5 400 356 362 411 423 458 481 496 502 523 5	52         591         584         591         651         666         707         731         747         753         774         791           43         581         584         593         655         670         711         735         750         756         775         791	821         8300 2         722         728         780         792         822         839         849         853         865         875         887           814         2         4000         725         731         785         797         829         847         858         862         874         883         892		
E 4000 356 362 411 423 458 481 496 502 523 5	43 581 8 4000 587 594 655 670 711 735 750 756 775 791	814 64000 725 731 785 797 829 847 858 862 874 883 892		
- 4501 333 338 383 395 429 451 465 471 491 F	10 547 4500 590 597 658 673 713 735 748 753 767 779	797 4500 729 735 789 802 835 854 864 868 876 882 881		
5000 307 312 353 364 396 416 430 436 456 4	73 508 5000 592 599 659 673 706 725 735 740 753 764	779 5000 732 739 794 807 841 855 862 864 869 870 870		
shortterm yield Ftarget	mediumterm yield Ftarget	longterm yield Ftarget		
shortterm yield Ftarget 0.1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0 0 200 275 381 0.33 0.48 0.400 0.00 500 570 578 5	Ftarget	Ftarget           0.2         0.1         0.12         0.12         0.14         0.15         0.16         0.17         0.18         0.2		
shortterm yield Ftarget 0.1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.0 2500 375 381 433 448 480 480 499 504 528 5 2500 375 482 737 442 480 490 490 491 491 514 5	Ftarget           11         0.102         0.12         0.125         0.14         0.157         0.16         0.17         0.18           51         598         2500         564         571         626         640         677         699         714         720         740         758	0.2         0.1         0.102         0.12         0.12         0.14         0.15         0.16         0.17         0.18         0.2           793         2500         701         707         756         767         795         810         818         822         832         840         852		
Ftarget 5 5 5 5 5 5 5 5 5 5 5 5 5	15         0.2         0.1         0.102         0.12         0.	Flarget         Flarget           02         0.1         0.12         0.12         0.15		
shortterm yield         Ftarget           0.1         0.102         0.12         0.122         0.14         0.15         0.16         0.17         0.16           2500         375         381         433         448         480         480         499         504         528         5           3164         368         373         427         442         480         480         493         491         514         5           60         3500         362         368         420         434         475         480         489         485         507         5           90         545         245         941         944         874         870         400         400	15         0.2         0.1         0.102         0.12         0.	Flarget         Flarget           02         0.1         0.12         0.12         0.15		
Shortterm yield         Ftarget           1         612         012 <th 0<="" colspa="2" td=""><td>Starget         Farget           16         0.2         0.1         0.102         0.12         0.12         0.12         0.15         0.16         0.17         0.16         0.17         0.18         0.15         0.16         0.17         0.18         0.15         0.16         0.17         0.19         0.12</td><td>Product         Output         Outpu         Outpu<!--</td--></td></th>	<td>Starget         Farget           16         0.2         0.1         0.102         0.12         0.12         0.12         0.15         0.16         0.17         0.16         0.17         0.18         0.15         0.16         0.17         0.18         0.15         0.16         0.17         0.19         0.12</td> <td>Product         Output         Outpu         Outpu<!--</td--></td>	Starget         Farget           16         0.2         0.1         0.102         0.12         0.12         0.12         0.15         0.16         0.17         0.16         0.17         0.18         0.15         0.16         0.17         0.18         0.15         0.16         0.17         0.19         0.12	Product         Output         Outpu         Outpu </td	
No         No<	Starget         Farget           16         0.2         0.12         0.12         0.12         0.12         0.12         0.15         0.16         0.17         0.16         0.17         0.18         0.15         0.16         0.17         0.18         0.15         0.16         0.17         0.18         0.17         0.18         0.17         0.18         0.17         0.18         0.17         0.15         0.16         0.17         0.18         0.17         0.18         0.17         0.18         0.17         0.18         0.17         0.17         7.20         7.40         7.88         30         572         565         572         626         639         678         701         7.17         7.23         7.42         7.61           30         572         565         572         626         641         679         702         7.18         7.25         7.44         760           30         572         566         573         630         644         683         705         719         724         741         756           34         500         568         574         631         645         683         705         719         724 <td>Visit of the second s</td>	Visit of the second s		
No         No<	Starget         Farget           16         0.2         0.12         0.12         0.12         0.12         0.12         0.15         0.16         0.17         0.16         0.17         0.18         0.15         0.16         0.17         0.18         0.15         0.16         0.17         0.18         0.17         0.18         0.17         0.18         0.17         0.18         0.17         0.15         0.16         0.17         0.18         0.17         0.18         0.17         0.18         0.17         0.18         0.17         0.17         7.20         7.40         7.88         30         572         565         572         626         639         678         701         7.17         7.23         7.42         7.61           30         572         565         572         626         641         679         702         7.18         7.25         7.44         760           30         572         566         573         630         644         683         705         719         724         741         756           34         500         568         574         631         645         683         705         719         724 <td>Visit of the second s</td>	Visit of the second s		
80 000 000 000 000         3500 000         3600 000         3600 000         3600 000         3400 000         3400<	1         0.102         0.12         0.12         0.12         0.12         0.12         0.13         0.15         0.16         0.17         0.16         0.17         0.16         0.17         0.18         0.15         0.16         0.17         0.16         0.17         0.18         0.15         0.16         0.17         0.16         0.17         0.18         0.15         0.16         0.17         0.18         0.17         0.18         0.15         0.16         0.17         0.18         0.15         0.16         0.17         0.18         0.17         0.18         0.17         0.18         0.17         7.00         7.40         7.80         3742         7.61         374         7.61         374         7.61         374         7.61         374         7.61         374         7.61         374         7.61         374         7.61         374         7.61         374         7.61         63         64         63         64         63         64         63         64         64         63         64         64         64         64         64         64         64         64         64         64         64         64         64         64         64	02         0.10         0.102         0.12         0.12         0.15		
No         Description         362         368         420         434         475         480         489         485         507         55           20         20         345         351         399         412         448         472         479         480         496         5           4000         345         351         399         412         448         472         479         480         496         5           4000         323         328         373         385         419         441         455         462         480         4           5000         301         306         349         360         392         412         426         432         450         4           5000         301         306         349         360         392         412         428         432         450         4	Target       Farget         1       0.102       0.12       0.12       0.12       0.15       0.16       0.17       0.16         15       598       564       571       626       640       677       699       714       720       740       758         36       580       3184       565       571       626       639       678       701       717       723       742       761         30       572       566       572       626       641       679       702       718       725       744       761         16       554       4000       566       573       630       644       683       705       719       725       744       760         94       530       560       566       573       630       644       683       705       719       724       741       756         69       500       568       575       632       646       680       702       714       719       733       746         mediumterm yield       Ftarget	01         0102         0.12         0.12         0.14         0.15         0.15         0.17         0.18         0.2           793         2500         701         707         756         779         810         818         822         832         840         852           793         3184         703         709         759         770         800         815         826         830         841         850         864           791         3500         705         710         761         773         803         819         829         833         845         855         868           788         4500         707         713         764         776         807         824         835         839         851         860         872           779         4500         707         713         767         779         811         829         838         842         853         863         871           765         5000         711         717         783         815         831         841         845         855         861         865		
%000 2000         3500         362         368         420         434         475         480         489         485         507         55           4000         345         351         399         412         448         472         479         480         496         55           4500         323         328         373         385         419         441 <b>455</b> 463         480         48	Target         Farget           1         0.10         0.120         0.12         0.125         0.14         0.15         0.157         0.16         0.17         0.165         0.167         0.17         0.120         0.12         0.126         0.17         0.167         0.16         0.17         0.105         0.167         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17         0.16         0.17<	02         01         0.102         0.13         0.13         0.13         0.14         0.15         0.14         0.15         0.14         0.15         0.14         0.15         0.14         0.15         0.14         0.15         0.14         0.15         0.14         0.15         0.15         0.16         0.15         0.15         0.16         0.15         0.15         0.16         0.		
%000 2000         3500         362         368         420         434         475         480         489         485         507         55           4000         345         351         399         412         448         472         479         480         496         55           4500         323         328         373         385         419         441 <b>455</b> 463         480         48	15     0.2     0.1     0.102     0.12     0.12     0.12     0.13     0.15     0.16     0.17     0.16       51     598     564     571     626     630     677     699     714     720     740     758       36     580     3500     565     572     626     639     678     699     714     720     740     758       30     572     566     571     626     639     678     701     717     723     742     761       16     554     4000     566     572     626     641     679     702     718     725     744     760       94     530     500     568     574     631     645     683     705     719     725     744     760       94     530     500     568     574     631     645     683     705     719     725     744     760       94     530     500     568     574     631     645     683     705     719     725     744     760       94     530     500     568     575     632     646     600     702     714     719     73	01         0102         012         012         014         015         015         016         017         016         02           793         2500         701         707         756         767         795         810         818         822         832         840         852           793         3164         703         709         759         770         800         815         826         830         841         850         864           781         5350         705         710         761         773         803         819         828         833         845         855         868           786         400         707         713         764         776         807         828         833         845         855         868           765         5000         711         717         707         783         815         811         845         855         861         865           5000         711         717         707         783         815         811         845         855         861         865           1000tterts <td rowspant<<="" td=""></td>		
%000 2000         3500         362         368         420         434         475         480         489         485         507         55           4000         345         351         399         412         448         472         479         480         496         55           4500         323         328         373         385         419         441 <b>455</b> 463         480         48	16       0.2       0.10       0.12       0.12       0.12       0.12       0.13       0.15       0.16       0.17       0.16       0.17       0.18       0.15       0.16       0.17       0.15       0.16       0.17       0.15       0.16       0.17       0.15       0.16       0.17       0.15       0.16       0.17       0.15       0.16       0.17       0.15       0.16       0.17       0.15       0.16       0.17       0.15       0.16       0.17       0.15       0.16       0.17       0.18       0.17       720       740       758         30       572       666       571       626       639       678       701       717       723       742       761         16       554       4000       566       573       630       644       683       705       719       725       744       760         94       500       566       575       632       646       680       702       714       719       733       746         500       568       575       632       646       680       702       715       729       735       754       711       718       735 <t< td=""><td>02         0.1         0.102         0.12         0.12         0.14         0.15         0.15         0.17         0.18         0.22           793         2500         701         707         756         767         795         810         818         822         830         841         850         864           793         3184         703         709         759         770         803         819         829         833         845         855         868           788         400         707         713         764         776         807         829         833         845         855         868           788         4500         709         715         767         779         811         829         833         842         853         861         871           765         5000         711         717         707         783         815         831         841         845         855         866         865           Iongtern yield         Ftarget           Iongtern yield         Iongtern yield         Iongtern yield           Iongtern         <td <="" rowspan="4" td=""></td></td></t<>	02         0.1         0.102         0.12         0.12         0.14         0.15         0.15         0.17         0.18         0.22           793         2500         701         707         756         767         795         810         818         822         830         841         850         864           793         3184         703         709         759         770         803         819         829         833         845         855         868           788         400         707         713         764         776         807         829         833         845         855         868           788         4500         709         715         767         779         811         829         833         842         853         861         871           765         5000         711         717         707         783         815         831         841         845         855         866         865           Iongtern yield         Ftarget           Iongtern yield         Iongtern yield         Iongtern yield           Iongtern <td <="" rowspan="4" td=""></td>		
%000 2000         3500         362         368         420         434         475         480         489         485         507         55           4000         345         351         399         412         448         472         479         480         496         55           4500         323         328         373         385         419         441 <b>455</b> 463         480         48	16       0.2       0.10       0.12       0.12       0.12       0.12       0.13       0.15       0.16       0.17       0.16       0.17       0.18       0.15       0.16       0.17       0.15       0.16       0.17       0.15       0.16       0.17       0.15       0.16       0.17       0.15       0.16       0.17       0.15       0.16       0.17       0.15       0.16       0.17       0.15       0.16       0.17       0.15       0.16       0.17       0.15       0.16       0.17       0.18       0.17       720       740       758         30       572       666       571       626       639       678       701       717       723       742       761         16       554       4000       566       573       630       644       683       705       719       725       744       760         94       500       566       575       632       646       680       702       714       719       733       746         500       568       575       632       646       680       702       715       729       735       754       711       718       735 <t< td=""><td>02         0.1         0.102         0.12         0.12         0.14         0.15         0.15         0.17         0.18         0.22           793         2500         701         707         756         767         795         810         818         822         830         841         850         864           793         3184         703         709         759         770         803         819         829         833         845         855         868           788         400         707         713         764         776         807         829         833         845         855         868           788         4500         709         715         767         779         811         829         833         842         853         861         871           765         5000         711         717         707         783         815         831         841         845         855         866         865           Iongtern yield         Ftarget           Iongtern yield         Iongtern yield         Iongtern yield           Iongtern         <td <="" rowspan="4" td=""></td></td></t<>	02         0.1         0.102         0.12         0.12         0.14         0.15         0.15         0.17         0.18         0.22           793         2500         701         707         756         767         795         810         818         822         830         841         850         864           793         3184         703         709         759         770         803         819         829         833         845         855         868           788         400         707         713         764         776         807         829         833         845         855         868           788         4500         709         715         767         779         811         829         833         842         853         861         871           765         5000         711         717         707         783         815         831         841         845         855         866         865           Iongtern yield         Ftarget           Iongtern yield         Iongtern yield         Iongtern yield           Iongtern <td <="" rowspan="4" td=""></td>		
No.         No. <td>1         0.10         0.10         0.12         0.12         0.12         0.13         0.16         0.17         0.16         0.</td> <td>01         0102         017         756         767         795         810         818         822         830         841         850           793         2500         701         707         756         767         795         810         818         822         832         840         852           793         3184         703         709         759         770         800         815         826         830         841         850         864           793         5500         705         710         761         773         803         819         829         833         845         856         868           794         4400         707         713         764         776         801         811         829         838         842         853         863         871           4500         701         717         770         783         813         814         845         855         860         863         861           600         711         717         770         783         813         814         845         855         866         865           801         807</td>	1         0.10         0.10         0.12         0.12         0.12         0.13         0.16         0.17         0.16         0.	01         0102         017         756         767         795         810         818         822         830         841         850           793         2500         701         707         756         767         795         810         818         822         832         840         852           793         3184         703         709         759         770         800         815         826         830         841         850         864           793         5500         705         710         761         773         803         819         829         833         845         856         868           794         4400         707         713         764         776         801         811         829         838         842         853         863         871           4500         701         717         770         783         813         814         845         855         860         863         861           600         711         717         770         783         813         814         845         855         866         865           801         807		
No.         Soc.         362         368         420         434         475         480         489         485         507         55           200         345         351         399         412         448         472         479         480         496         5           4000         345         351         399         412         448         472         479         480         496         5           5000         301         306         349         360         392         412         426         432         450         4           5000         301         306         349         360         392         412         426         432         450         4           5000         301         306         349         360         392         412         426         432         450         4           5000         381         386         444         459         502         528         547         555         561         6           3164         388         444         459         502         529         548         556         582         6         350         388         444	1         0.10         0.10         0.12         0.12         0.13         0.15         0.16         0.17         0.16         0.	02         0.1         0.102         0.12         0.12         0.14         0.15         0.15         0.17         0.18         0.22           793         2500         701         707         756         767         795         810         818         822         830         841         850         864           793         3184         703         709         759         770         803         819         829         833         845         855         868           788         400         707         713         764         776         807         829         833         845         855         868           788         4500         709         715         767         779         811         829         833         842         853         861         871           765         5000         711         717         707         783         815         831         841         845         855         866         865           Iongtern yield         Ftarget           Iongtern yield         Iongtern yield         Iongtern yield           Iongtern <td <="" rowspan="4" td=""></td>		

Table 6

Yield, expressed as median catch (kt), in the short, medium, and long term for biomass rules without and with a constraint in interannual TAC change. Red shaded cells correspond to the non-precautionary [Ftarget, Btrigger] combinations [P(SSB< B<sub>lim</sub>)< 5%]. Cells shaded in green colours indicate the combinations that result in yield ≥95% of the maximum yield among the precautionary combinations.

# Yield tables for biomass rules with Risk3

		shortt	erm yi	ield	н	Rtarg	et					mediu	ntern	i yield	н	Rtarg	et					longte	rm yie	eld	н	Rtarg	et			
		0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15		0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15		0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15
	2500	293	333	372	411	449	486	524	561	598	2500	493	541	584	623	657	687	714	737	758	2500	633	680	720	751	778	799	814	825	833
	3184	292	331	370	408	446	483	520	556	591	_ 3184	494	542	586	626	661	692	721	745	766	_ 3184	634	682	722	755	783	805	822	836	846
<u>jge</u>	3500	289	328	366	403	440	477	512	548	582	B 3500	496	545	589	629	664	696	725	750	773	B 3500	635	683	724	758	786	809	828	842	853
Btrigger	4000	270	305	339	372	404	435	466	496	526	Btrigger 4000	499	549	594	635	672	706	736	762	784	BLID 1500	637	686	727	762	792	817	837	852	865
	4500	243	274	305	335	364	392	420	448	474	4500	502	553	600	642	679	714	743	769	791	4500	639	689	731	767	797	824	845	861	875
	5000	220	249	277	305	332	358	383	409	434	5000	506	557	604	646	683	717	745	767	781	5000	641	692	735	771	803	830	851	868	880
		shortt	erm yi	ield	ц	Rtarg	ot					mediu	mterm	ı yield	ц	Rtarg	ot					longte	rm yie	eld	ц	Rtarg	ot			
		0.07	0.08	0.09		0.11		0.13	0.14	0.15		0.07	0.08	0.09	0.1	0.11		0.13	0.14	0.15		0.07	0.08	0.09	0.1	0.11		0.13	0.14	0.1
	2500		346	374	402	430	459	489	518	547	2500		528	574	617	655	691	724	752	778	2500		686	727	761	788	810	825	837	84
trigger	3184	317	346	374	402	431	459	488	517	545	3184	480	531	578	621	660	697	730	760	787	3184	639	688	730	765	794	818	837	852	86
ger	3500	310	344	372	400	427	454	481	510	539	B 3500	483	534	581	624	664	701	735	765	791	B 3500	641	690	732	768	798	822	843	860	87
	4000	269	305	339	372	405	437	467	495	523	1900 radio 1900	488	539	587	631	672	710	743	772	796	1900 Hono	643	693	736	773	805	832	855	874	88
â	4500		274	305	335	364	393	421	448	475	4500	492	545	594	639	680	717	749	775	792	4500	646	697	741	779	813	841	865	883	89
	5000		249	277	305	332	358	383	409	434	5000	497	550	600	645	685	718	746	762	773	5000	649	701	747	787	821	850	872	882	87
			2.10	2		002				101		101			0.0							0.10						0.2		
		shortt	erm yi	ield	н	Rtarg	et					mediu	mterm	i yield	н	Rtarg	et					longte	rm yie	eld	н	Rtarg	et			
		0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15		0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15		0.07	0.08	0.09	0.1		0.12	0.13	0.14	0.15
	2500	307	331	370	408	447	480	491	526	562	2500	475	522	565	603	639	670	700	726	751	2500	622	669	708	741	767	788	805	819	82
-	3184	307	330	369	407	445	480	482	515	550	_ 3184	478	526	570	609	645	678	707	735	760	_ 3184	624	671	711	746	774	797	816	831	84
<u> 3</u> 6	3500	303	327	365	402	439	477	480	499	531	B 3500	480	529	574	613	649	683	713	741	766	B 3500	625	672	714	748	777	802	821	838	85
Btrigger	4000	270	305	338	371	404	436	468	480	506	Btrigger 4000	485	534	579	620	659	693	723	749	773	Btrigger 14000	628	676	718	754	784	810	831	848	86
-	4500	242	274	304	335	364	392	421	448	475	4500	490	540	585	627	665	698	729	754	775	4500	631	680	723	759	791	817	839	856	87
	5000	220	249	277	305	332	358	383	409	434	5000	493	543	589	631	669	702	730	755	770	5000	633	684	727	765	796	822	845	862	87
		shortt	erm vi	bld								mediu	mterm	vield								longte	rm vie	ald						
		3110110	cititi yi	iciu	н	Rtarg	et					neuru	mern	yield	н	Rtarg	et					longte	iiii ya	au	н	Rtarg	et			
		0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15		0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15		0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.1
	2500			372	410	448	486	523	560	596	2500	493	542	585	625	660	692	722	748	773	2500		681	722	755	784	807	827	843	85
			330	368	406	443	480	516	552	586	3184	495	544	589	630	667	702	734	762	789	3184	634	683	724	759	789	815	837	855	87
L.	3184								537	570	<b>6</b> 3500	496	546	592	634	672	708	740	770	798	900 3500		684	726	761	792	819	842	861	87
gger		289	327	364	401	436	471	505			6																			00
Btrigger		289		364 332	401 357	436 383	471 407	428	449	469	Btrigger 4000	498	549	596	640	680	717	751	781	809	La 4000	636	686	728	765	797	826	849	870	88
Btrigger		289 274	327								4000 4500	498 499	549 552	596 600	640 645	680 686	717 724	751 756	781 787	809 814	4000 4500		686 687	728 731	765 769	797 802	826 831	849 855	870 877	88 89

shortterm IAV-Yield

Ftarget

0.1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.18 0.2

3184 21.3 21.3 21.8 21.9 22.4 22.7 23.0 23.1 23.5 23.8 24.5

4500 27.9 27.9 28.2 28.2 28.4 28.5 28.6 28.6 28.9 29.1 29.5

5000 29.1 29.1 29.3 29.2 29.3 29.3 29.4 29.5 29.7 29.8 30.1

0.1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.18 0.2

2500 9.5 9.6 10.0 10.2 10.8 11.1 11.4 11.5 11.9 12.3 13.0

3184 13.9 14.0 14.6 14.8 15.5 15.8 16.2 16.3 16.7 17.1 18.0

shortterm IAV-Yield Ftarget

 b
 3500
 23.1
 23.1
 23.7
 23.8
 24.3
 24.7
 24.9
 25.0
 25.2
 25.6
 26.5

 4000
 25.8
 25.9
 26.3
 26.4
 26.8
 27.0
 27.3
 27.4
 27.7
 27.9
 28.4

Table 7

0'0

through

F-rule

Sule .

constr

average (

Median interannual variability (IAV, expressed as a %) in yield in the medium term for F rules without and with a constraint in interannual TAC change. Unshaded cells correspond to the precautionary [Ftarget, Btrigger] combinations  $[P(SSB < B_{lim}) \le 5\%].$ 

# Interannual variability in yield - F-rules - Risk3

### mediumterm IAV-Yield Ftarget 0.1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.18 0.2 2500 18.5 18.6 18.9 18.9 19.3 19.6 19.8 19.9 20.2 20.5 21.1

2500 17.7 17.8 18.4 18.6 19.1 19.5 19.8 19.9 20.4 20.8 21.8 3184 18.4 18.5 19.3 19.5 20.2 20.6 20.9 21.1 21.6 22.1 23.1 
 B
 3500
 18.8
 18.9
 19.7
 20.0
 20.7
 21.1
 21.5
 21.7
 22.2
 22.7
 23.7

 4000
 19.4
 19.5
 20.5
 20.7
 21.5
 22.4
 22.6
 23.1
 23.6
 24.7
 4500 20.1 20.2 21.2 21.5 22.3 22.9 23.2 23.4 23.9 24.4 25.4 5000 20.9 21.0 22.0 22.3 23.0 23.6 24.0 24.2 24.6 25.1 26.1

mediumterm IAV-Yield Ftarget 2500 9.2 9.2 9.7 9.9 10.3 10.7 10.9 11.0 11.4 11.8 12.6 3184 9.9 10.0 10.6 10.8 11.4 11.8 12.2 12.3 12.8 13.3 14.4 8 3500 10.2 10.3 11.0 11.3 12.0 12.5 12.9 13.0 13.5 14.1 15.2 4000 11.0 11.1 12.0 12.3 13.1 13.7 14.1 14.2 14.8 15.5 16.7 4500 11.9 12.1 13.1 13.3 14.2 14.9 15.4 15.6 16.2 16.9 18.3 5000 13.0 13.1 14.2 14.5 15.6 16.3 16.8 17.0 17.7 18.4 19.9

# mediumterm IAV-Yield Ftarget

0.1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.18 0.2 Btrigge 4500 20.0 20.0 20.0 20.0 20.6 21.5 22.0 22.3 23.0 23.7 25.0 5000 20.0 20.1 21.1 21.5 22.7 23.3 23.9 24.0 24.6 25.0 25.0

# mediumterm IAV-Yield Ftarget

0.1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.18 0.2 2500 17.9 18.0 18.7 18.9 19.4 19.9 20.2 20.3 20.8 21.3 22.2 3184 18.9 19.0 20.0 20.4 21.4 22.0 22.5 22.7 23.4 24.3 25.9 b 3500 19.3 19.4 20.6 21.0 22.0 22.8 23.3 23.6 24.4 25.3 27.1 4000 19.9 20.0 21.3 21.7 22.9 23.8 24.4 24.8 25.6 26.6 28.5 4500 20.3 20.5 22.0 22.4 23.8 24.6 25.3 25.6 26.5 27.4 29.3 5000 20.7 20.9 22.5 22.9 24.3 25.2 25.8 26.0 27.1 28.0 29.8

#### longterm IAV-Yield Ftarget 0.1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.18 0.2 2500 16.8 16.9 17.6 17.8 18.4 18.8 19.1 19.2 19.7 20.1 21.1 3184 17.1 17.2 18.0 18.3 18.9 19.5 19.8 20.0 20.5 21.1 22.2 3500 17.3 17.4 18.3 18.5 19.3 19.8 20.2 20.4 21.0 21.5 22.7 Btri 4000 17.7 17.8 18.8 19.0 19.9 20.5 20.9 21.1 21.7 22.3 23.5 4500 18.2 18.3 19.3 19.6 20.5 21.2 21.6 21.8 22.4 23.1 24.3 5000 18.7 18.8 19.9 20.2 21.2 21.8 22.3 22.5 23.1 23.7 25.0

# longterm IAV-Yield

							targe	et.				
		0.1	0.102	0.12	0.125	0.14	0.15	0.157	0.16	0.17	0.18	0.2
	2500	8.9	8.9	9.5	9.6	10.1	10.5	10.8	10.9	11.4	11.8	12.7
	3184	9.2	9.3	9.9	10.1	10.8	11.2	11.6	11.8	12.3	12.8	14.0
Btrigger	3500	9.4	9.5	10.2	10.4	11.2	11.7	12.1	12.2	12.8	13.4	14.6
Btric	4000	9.8	9.9	10.8	11.0	11.9	12.5	12.9	13.1	13.7	14.4	15.7
_	4500	10.3	10.4	11.4	11.7	12.6	13.3	13.8	14.0	14.7	15.4	16.9
	5000	10.9	11.0	12.1	12.5	13.5	14.3	14.8	15.0	15.8	16.6	18.1

#### Ionaterm IAV-Yield

Ftarget 0.1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.18 0.2 2500 17.5 17.6 18.5 18.8 19.7 20.0 20.1 20.0 20.0 20.0 20.0 3184 17.9 18.0 19.1 19.4 20.0 20.0 20.1 20.0 20.0 20.0 20.0 4500 19.1 19.2 20.0 20.0 20.0 20.0 19.9 20.0 20.0 20.0 21.3 5000 19.7 19.7 20.0 20.0 20.0 20.0 19.9 20.0 20.0 20.8 23.0

#### longterm IAV-Yield Ftarget

0.1 0.102 0.12 0.125 0.14 0.15 0.157 0.16 0.17 0.18 0.2 2500 16.9 17.0 17.7 17.9 18.5 18.9 19.2 19.4 19.9 20.4 21.4 3184 17.3 17.4 18.4 18.7 19.5 20.2 20.7 21.0 21.6 22.5 24.3 3500 17.5 17.6 18.7 19.0 20.1 20.8 21.4 21.6 22.5 23.4 25.2 4000 17.9 18.0 19.2 19.6 20.8 21.6 22.3 22.5 23.5 24.4 26.4 4500 18.2 18.4 19.7 20.1 21.4 22.3 23.0 23.3 24.3 25.2 27.3 5000 18.6 18.8 20.3 20.7 22.0 22.9 23.6 23.9 24.8 25.8 27.9

ğ		3184	13.9	14.0	14.6	14.8	15.5	15.8	16.2	16.3	16.7	17.1	18.0
vera	jgei	3500	16.9	17.0	17.5	17.7	18.1	18.5	18.7	18.9	19.3	19.7	20.5
ith a	Strig	4000	21.0	21.1	21.8	21.8	22.3	22.5	22.7	22.7	23.0	23.3	23.9
1 ×	-	4500	24.1	24.2	24.6	24.8	25.1	25.2	25.4	25.4	25.6	25.9	26.3
Rule 1 with average		5000	26.5	26.5	26.8	26.8	27.0	27.1	27.2	27.2	27.3	27.4	27.8
			short	term	IAV-	Vield							
aint		,	SHOL		1/10-	TIER		targe	et				
Istra			0.1	0.102	0.12	0.125	0.14	0.15	0.157	0.16	0.17	0.18	0.2
5		2500	19.9	19.9	20.0	20.0	20.0	20.0	20.6	20.4	22.4	24.4	25.0
IAC		3184	23.3	23.3	23.8	24.1	25.0	25.0	25.1	25.0	25.0	25.0	25.0
. %0	Iger	3500	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
25/2	Btrig	4000	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
vith	-	4500	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Rule 1 with 25/20% TAC-constraint		5000	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0	25.0
Rul						V:-1-							_
		1	snort	term	IAV-	rield	F	targe	et				
0.05			0.1	0.102	0.12	0.125	0.14	0.15	0.157	0.16	0.17	0.18	0.2
0		2500	19.2	19.3	19.7	19.9	20.3	20.8	21.1	21.3	21.8	22.2	23.2
Ē		3184	23.7	23.8	25.6	26.1	27.6	28.8	29.5	29.8	31.1	32.3	34.6
ith F	1ger	3500	26.3	26.5	28.7	29.4	31.3	32.4	33.3	33.6	34.8	36.0	38.8
2 - F-rule with Fmin =	Btric	4000	28.2	28.5	31.4	32.0	33.8	35.2	36.0	36.5	37.7	38.8	41.1
F	-	4500	29.0	29.3	31.7	32.5	34.4	35.6	36.5	36.8	38.0	39.0	40.9
e 2 -		5000	28.8	29.1	31.5	32.1	33.9	35.0	35.7	36.0	36.9	37.9	39.7
Rule 2				-									

Median interannual variability (IAV, expressed as a %) in yield in the medium term for biomass rules without and with constraint in interannual TAC change. Unshaded cells correspond to the precautionary  $[F_{target}, B_{trigger}]$  combinations  $[P(SSB < B_{lim}) \le 5\%]$ .

# Interannual variability in yield - biomass rules - Risk3

0'0 46	s	hortte	erm IA	v	н	Rtarg	et					mediu	mtern	n IAV	н	Rtarg	et					lo	ongte	rm IAV	V	н	Rtarg	et			
rough		0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15		0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15			0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15
10 11	2500	7.6	7.8	8.0	8.2	8.4	8.7	9.0	9.3	9.7	2500	7.9	8.3	8.9	9.4	10.0	10.6	11.3	12.0	12.7		2500	8.2	8.7	9.2	9.7	10.3	10.8	11.4	12.1	12.8
÷.	3184	8.6	8.8	9.1	9.4	9.7	10.1	10.4	10.8	11.3	3184	8.1	8.7	9.2	9.9	10.5	11.2	11.9	12.7	13.5	-	3184	8.3	8.8	9.3	9.9	10.5	11.2	11.9	12.6	13.4
iomass rul Btrigger	3500	10.0	10.2	10.5	10.8	11.1	11.5	12.0	12.4	13.0	1900 Iang 1900	8.3	8.9	9.5	10.1	10.8	11.5	12.3	13.0	13.9	Btrigger	3500	8.4	8.9	9.5	10.1	10.7	11.4	12.1	12.9	13.8
- biomass Btrigg	4000	12.4	12.6	12.8	13.1	13.4	13.5	13.9	14.2	14.7	ili 4000	8.6	9.2	9.8	10.5	11.2	12.0	12.8	13.6	14.4	Btrić	4000	8.5	9.1	9.7	10.3	11.0	11.8	12.6	13.4	14.3
	4500	13.6	13.7	13.8	14.0	14.2	14.4	14.6	14.7	15.0	4500	8.9	9.5	10.2	11.0	11.7	12.4	13.2	14.1	14.9			8.6	9.3	9.9	10.6	11.4	12.2	13.1	13.9	14.8
Rule	5000	14.1	14.1	14.2	14.3	14.4	14.6	14.7	14.9	15.0	5000	9.2	9.9	10.6	11.3	12.1	12.9	13.7	14.5	15.4		5000	8.8	9.5	10.2	11.0	11.8	12.6	13.5	14.4	15.3
-																															_
	s	hortte	erm IA	AV .	н	Rtarg	et					mediu	mtern	1 IAV	н	Rtarg	et					lo	ongte	rm IA\	v	н	Rtarg	et			
traint	,	0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15		0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15			0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15
cons	2500	7.9	6.8	6.0	5.6	5.8	6.3	7.0	7.8	8.6	2500	6.3	6.6	6.9	7.2	7.6	8.0	8.4	8.9	9.4		2500	6.3	6.7	7.1	7.5	7.9	8.3	8.8	9.4	9.9
	3184	8.9	8.0	7.5	7.8	8.1	8.6	9.3	10.1	11.0	3184	6.5	6.9	7.2	7.6	8.1	8.6	9.2	9.8	10.4	-	3184	6.5	6.8	7.3	7.7	8.2	8.7	9.3	10.0	10.6
ave	3500	10.3	10.1	9.9	9.9	10.1	10.5	11.3	12.1	13.0	B 3500	6.7	7.1	7.5	8.0	8.5	9.0	9.6	10.2	10.9	jgei	3500	6.5	6.9	7.4	7.9	8.4	9.0	9.6	10.3	11.0
btrigger	4000	12.6	12.4	12.4	12.6	12.8	13.2	13.5	14.0	14.6	1900 1000 1000 1000 1000 1000 1000 1000	7.1	7.5	7.9	8.4	8.9	9.5	10.3	10.9	11.7	Btrigger	4000	6.6	7.1	7.6	8.1	8.8	9.4	10.1	10.9	11.7
	4500	13.6	13.6	13.7	13.8	14.0	14.3	14.6	14.8	15.0	4500	7.5	7.9	8.4	9.0	9.6	10.2	10.9	11.7	12.4	-		6.8	7.3	7.9	8.5	9.2	9.9	10.7	11.4	12.3
	5000	14.3	14.3	14.3	14.5	14.6	14.8	14.9	15.1	15.2	5000	7.9	8.4	8.9	9.5	10.2	10.8	11.6	12.3	13.1		5000	7.0	7.6	8.2	8.9	9.6	10.4	11.2	12.0	12.9
		hadt										and in	mterm											rm IA)							
	s	hortte	enn 14		н	Rtarg	et					neulu	mem		н	Rtarg	et						ongro		*	н	Rtarg	et			
aint	s	0.07	0.08	0.09		0.11	0.12		0.14			0.07	0.08	0.09	0.1	0.11	0.12		0.14				0.07	0.08	0.09	0.1	0.11	0.12		0.14	
onstraint	S 2500	0.07					0.12		0.14 13.1		2500			0.09	0.1		0.12					Г	-	0.08	0.09		0.11	0.12			
00	2500	0.07 11.0	0.08	0.09 8.9	0.1 9.1	0.11	0.12 10.1	11.5	13.1	15.6	2500	0.07	0.08	0.09	0.1 11.3	0.11	0.12 12.6	13.4		14.9		2500 3184	0.07	0.08 9.7	0.09 10.3	0.1	0.11 11.6	0.12 12.3	13.1	13.9	14.7
00	2500 3184	0.07 11.0 11.5	0.08 9.3 10.0	0.09 8.9 10.0	0.1 9.1	0.11 9.4 10.8	0.12 10.1 11.7	11.5 13.2	13.1 15.2	15.6	2500	0.07 9.6	0.08 10.1 10.4	0.09	0.1 11.3 11.7	0.11	0.12 12.6 13.2	13.4 14.0	14.2	14.9 15.9		2500 3184	0.07 9.1	0.08 9.7 9.8	0.09 10.3 10.5	0.1 11.0	0.11 11.6 11.9	0.12 12.3 12.6	13.1 13.5	13.9	14.7 15.4
00	2500 3184 3500	0.07 11.0 11.5 12.1	0.08 9.3 10.0	0.09 8.9 10.0 11.3	0.1 9.1 10.3 11.7	0.11 9.4 10.8	0.12 10.1 11.7 13.2	11.5 13.2 14.5	13.1 15.2 16.0	15.6 17.7	2500 3184	0.07 9.6 9.8 9.9	0.08 10.1 10.4 10.5	0.09 10.7 11.0 11.2	0.1 11.3 11.7 12.0	0.11 11.9 12.4	0.12 12.6 13.2 13.5	13.4 14.0 14.4	14.2 14.9	14.9 15.9 16.2	igger	2500 3184	0.07 9.1 9.2	0.08 9.7 9.8 9.9	0.09 10.3 10.5 10.5	0.1 11.0 11.1 11.3	0.11 11.6 11.9	0.12 12.3 12.6 12.8	13.1 13.5 13.7	13.9 14.4	14.7 15.4 15.7
with 25/20% TAC-con Btrigger	2500 3184 3500 4000	0.07 11.0 11.5 12.1 13.6	0.08 9.3 10.0 11.1 13.6	0.09 8.9 10.0 11.3 13.8	0.1 9.1 10.3 11.7	0.11 9.4 10.8 12.2 14.4	0.12 10.1 11.7 13.2 14.8	11.5 13.2 14.5 15.5	13.1 15.2 16.0 16.3	15.6 17.7 17.9 17.0	2500	0.07 9.6 9.8 9.9 10.3	0.08 10.1 10.4 10.5 10.9	0.09 10.7 11.0 11.2 11.7	0.1 11.3 11.7 12.0 12.5	0.11 11.9 12.4 12.7	0.12 12.6 13.2 13.5 14.0	13.4 14.0 14.4 14.9	14.2 14.9 15.3 15.8	14.9 15.9 16.2 16.7		2500 3184 3500 4000	0.07 9.1 9.2 9.3 9.4	0.08 9.7 9.8 9.9	0.09 10.3 10.5 10.5 10.7	0.1 11.0 11.1 11.3 11.5	0.11 11.6 11.9 12.0 12.3	0.12 12.3 12.6 12.8 13.2	13.1 13.5 13.7 14.1	13.9 14.4 14.7 15.1	14.7 15.4 15.7 16.1
3 with 25/20% TAC-con Btrigger	2500 3184 3500 4000 4500	0.07 11.0 11.5 12.1 13.6 14.8	0.08 9.3 10.0 11.1 13.6 14.8	0.09 8.9 10.0 11.3 13.8 14.9	0.1 9.1 10.3 11.7 14.0	0.11 9.4 10.8 12.2 14.4 15.1	0.12 10.1 11.7 13.2 14.8 15.4	11.5 13.2 14.5 15.5 15.7	13.1 15.2 16.0 16.3 16.0	15.6 17.7 17.9 17.0 16.3	2500 3184 50 550 4000 4500	0.07 9.6 9.8 9.9 10.3 10.6	0.08 10.1 10.4 10.5 10.9	0.09 10.7 11.0 11.2 11.7 12.1	0.1 11.3 11.7 12.0 12.5 12.9	0.11 11.9 12.4 12.7 13.3 13.7	0.12 12.6 13.2 13.5 14.0 14.5	13.4 14.0 14.4 14.9 15.4	14.2 14.9 15.3 15.8 16.3	14.9 15.9 16.2 16.7 17.1		2500 3184 3500 4000 4500	0.07 9.1 9.2 9.3 9.4 9.5	0.08 9.7 9.8 9.9 10.0	0.09 10.3 10.5 10.5 10.7 11.0	0.1 11.0 11.1 11.3 11.5 11.8	0.11 11.6 11.9 12.0 12.3 12.7	0.12 12.3 12.6 12.8 13.2 13.6	13.1 13.5 13.7 14.1 14.6	13.9 14.4 14.7 15.1 15.5	14.7 15.4 15.7 16.1 16.6
3 with 25/20% TAC-con Btrigger	2500 3184 3500 4000 4500 5000	0.07 11.0 11.5 12.1 13.6 14.8 15.2	0.08 9.3 10.0 11.1 13.6 14.8 15.1	0.09 <b>8.9</b> 10.0 11.3 13.8 14.9 15.1	0.1 9.1 10.3 11.7 14.0 15.0	0.11 9.4 10.8 12.2 14.4 15.1	0.12 10.1 11.7 13.2 14.8 15.4	11.5 13.2 14.5 15.5 15.7	13.1 15.2 16.0 16.3 16.0	15.6 17.7 17.9 17.0 16.3	2500 3184 500 4500 5000	0.07 9.6 9.8 9.9 10.3 10.6 11.0	0.08 10.1 10.4 10.5 10.9 11.3 11.7	0.09 10.7 11.0 11.2 11.7 12.1 12.5	0.1 11.3 11.7 12.0 12.5 12.9	0.11 11.9 12.4 12.7 13.3 13.7	0.12 12.6 13.2 13.5 14.0 14.5	13.4 14.0 14.4 14.9 15.4	14.2 14.9 15.3 15.8 16.3	14.9 15.9 16.2 16.7 17.1		2500 3184 3500 4000 4500 5000	0.07 9.1 9.2 9.3 9.4 9.5 9.7	0.08 9.7 9.8 9.9 10.0 10.2 10.5	0.09 10.3 10.5 10.5 10.7 11.0 11.3	0.1 11.0 11.1 11.3 11.5 11.8	0.11 11.6 11.9 12.0 12.3 12.7	0.12 12.3 12.6 12.8 13.2 13.6	13.1 13.5 13.7 14.1 14.6	13.9 14.4 14.7 15.1 15.5	14.7 15.4 15.7 16.1 16.6
05 Rule 3 with 25/20% TAC-con Btrigger	2500 3184 3500 4000 4500 5000	0.07 11.0 11.5 12.1 13.6 14.8 15.2	0.08 9.3 10.0 11.1 13.6 14.8	0.09 <b>8.9</b> 10.0 11.3 13.8 14.9 15.1	0.1 9.1 10.3 11.7 14.0 15.0 15.2	0.11 9.4 10.8 12.2 14.4 15.1	0.12 10.1 11.7 13.2 14.8 15.4 15.5	11.5 13.2 14.5 15.5 15.7	13.1 15.2 16.0 16.3 16.0	15.6 17.7 17.9 17.0 16.3	2500 3184 500 4500 5000	0.07 9.6 9.8 9.9 10.3 10.6 11.0	0.08 10.1 10.4 10.5 10.9 11.3	0.09 10.7 11.0 11.2 11.7 12.1 12.5	0.1 11.3 11.7 12.0 12.5 12.9 13.3	0.11 11.9 12.4 12.7 13.3 13.7	0.12 12.6 13.2 13.5 14.0 14.5 14.9	13.4 14.0 14.4 14.9 15.4	14.2 14.9 15.3 15.8 16.3	14.9 15.9 16.2 16.7 17.1		2500 3184 3500 4000 4500 5000	0.07 9.1 9.2 9.3 9.4 9.5 9.7	0.08 9.7 9.8 9.9 10.0 10.2	0.09 10.3 10.5 10.5 10.7 11.0 11.3	0.1 11.0 11.1 11.3 11.5 11.8 12.2	0.11 11.6 11.9 12.0 12.3 12.7	0.12 12.3 12.6 12.8 13.2 13.6 14.0	13.1 13.5 13.7 14.1 14.6	13.9 14.4 14.7 15.1 15.5	14.7 15.4 15.7 16.1 16.6
05 Rule 3 with 25/20% TAC-con Btrigger	2500 3184 3500 4000 4500 5000	0.07 11.0 11.5 12.1 13.6 14.8 15.2	0.08 9.3 10.0 11.1 13.6 14.8 15.1	0.09 8.9 10.0 11.3 13.8 14.9 15.1 V 0.09	0.1 9.1 10.3 11.7 14.0 15.0 15.2 H 0.1	0.11 9.4 10.8 12.2 14.4 15.1 15.3	0.12 10.1 11.7 13.2 14.8 15.4 15.5	11.5 13.2 14.5 15.5 15.7	13.1 15.2 16.0 16.3 16.0	15.6 17.7 17.9 17.0 16.3	2500 3184 500 4500 5000	0.07 9.6 9.8 9.9 10.3 10.6 11.0 mediu	0.08 10.1 10.4 10.5 10.9 11.3 11.7 mterm 0.08	0.09 10.7 11.0 11.2 11.7 12.1 12.5 12.5 1AV 0.09	0.1 11.3 11.7 12.0 12.5 12.9 13.3 H 0.1	0.11 11.9 12.4 12.7 13.3 13.7 14.1	0.12 12.6 13.2 13.5 14.0 14.5 14.9	13.4 14.0 14.4 14.9 15.4	14.2 14.9 15.3 15.8 16.3 16.6	14.9 15.9 16.2 16.7 17.1		2500 3184 3500 4000 4500 5000	0.07 9.1 9.2 9.3 9.4 9.5 9.7	0.08 9.7 9.8 9.9 10.0 10.2 10.5 rm IAV 0.08	0.09 10.3 10.5 10.5 10.7 11.0 11.3 V 0.09	0.1 11.0 11.1 11.3 11.5 11.8 12.2 H 0.1	0.11 11.6 11.9 12.0 12.3 12.7 13.1 Rtarg 0.11	0.12 12.3 12.6 12.8 13.2 13.6 14.0 et 0.12	13.1 13.5 13.7 14.1 14.6 14.9	13.9 14.4 14.7 15.1 15.5 16.0	14.7 15.4 15.7 16.1 16.6
1 = 0.05 Rule 3 with 25/20% TAC-con Btrigger	2500 3184 3500 4000 5000 S	0.07 11.0 11.5 12.1 13.6 14.8 15.2 chortte	0.08 9.3 10.0 11.1 13.6 14.8 15.1 erm IA	0.09 8.9 10.0 11.3 13.8 14.9 15.1 V 0.09 8.2	0.1 9.1 10.3 11.7 14.0 15.0 15.2 H 0.1 8.4	0.11 9.4 10.8 12.2 14.4 15.1 15.3 Rtarg 0.11 8.7	0.12 10.1 11.7 13.2 14.8 15.4 15.5 et 0.12 9.0	11.5 13.2 14.5 15.5 15.7 15.6	13.1 15.2 16.0 16.3 16.0 15.7	15.6 17.7 17.9 17.0 16.3 15.9	2500 3184 500 4500 5000	0.07 9.6 9.8 9.9 10.3 10.6 11.0 mediu 0.07 7.9	0.08 10.1 10.4 10.5 10.9 11.3 11.7 mterm 0.08 8.3	0.09 10.7 11.0 11.2 11.7 12.1 12.5 12.5 1AV 0.09 8.9	0.1 11.3 11.7 12.0 12.5 12.9 13.3 H 0.1 9.4	0.11 11.9 12.4 12.7 13.3 13.7 14.1 Rtarg 0.11 10.0	0.12 12.6 13.2 13.5 14.0 14.5 14.9 0.12 10.6	13.4 14.0 14.4 14.9 15.4 15.7 0.13 11.2	14.2 14.9 15.3 15.8 16.3 16.6 0.14 11.9	14.9 15.9 16.2 16.7 17.1 17.4 0.15 12.5		2500 3184 3500 4000 4500 5000	0.07 9.1 9.2 9.3 9.4 9.5 9.7	0.08 9.7 9.8 9.9 10.0 10.2 10.5	0.09 10.3 10.5 10.5 10.7 11.0 11.3	0.1 11.0 11.1 11.3 11.5 11.8 12.2 H 0.1 9.7	0.11 11.6 11.9 12.0 12.3 12.7 13.1 Rtargo 0.11 10.2	0.12 12.3 12.6 12.8 13.2 13.6 14.0 et 0.12 10.8	13.1 13.5 13.7 14.1 14.6 14.9 0.13 11.4	13.9 14.4 14.7 15.1 15.5 16.0 0.14 12.0	14.7 15.4 15.7 16.1 16.6 17.0 0.15 12.7
th HRmin = 0.05 Rule 3 with 25/20% TAC-con Btrigger	2500 3184 3500 4000 5000 S 2500	0.07 11.0 11.5 12.1 13.6 14.8 15.2 shortte	0.08 9.3 10.0 11.1 13.6 14.8 15.1 erm IA 0.08	0.09 8.9 10.0 11.3 13.8 14.9 15.1 V 0.09	0.1 9.1 10.3 11.7 14.0 15.0 15.2 H 0.1 8.4	0.11 9.4 10.8 12.2 14.4 15.1 15.3 Rtarg	0.12 10.1 11.7 13.2 14.8 15.4 15.5 et 0.12 9.0	11.5 13.2 14.5 15.5 15.7 15.6 0.13 9.3	13.1 15.2 16.0 16.3 16.0 15.7	15.6 17.7 17.9 17.0 16.3 15.9 0.15 10.1	2500 3184 4000 4000 5000 2500	0.07 9.6 9.8 9.9 10.3 10.6 11.0 mediu	0.08 10.1 10.4 10.5 10.9 11.3 11.7 mterm 0.08	0.09 10.7 11.0 11.2 11.7 12.1 12.5 12.5 1AV 0.09	0.1 11.3 11.7 12.0 12.5 12.9 13.3 H 0.1	0.11 11.9 12.4 12.7 13.3 13.7 14.1 Rtarg 0.11 10.0	0.12 12.6 13.2 13.5 14.0 14.5 14.9 0.12 10.6	13.4 14.0 14.4 14.9 15.4 15.7 0.13 11.2	14.2 14.9 15.3 15.8 16.3 16.6	14.9 15.9 16.2 16.7 17.1 17.4 0.15 12.5	Btrigger	2500 3184 3500 4000 5000 8 2500 3184	0.07 9.1 9.2 9.3 9.4 9.5 9.7 0.07	0.08 9.7 9.8 9.9 10.0 10.2 10.5 rm IAV 0.08	0.09 10.3 10.5 10.5 10.7 11.0 11.3 V 0.09	0.1 11.0 11.1 11.3 11.5 11.8 12.2 H 0.1	0.11 11.6 11.9 12.0 12.3 12.7 13.1 Rtarg 0.11	0.12 12.3 12.6 12.8 13.2 13.6 14.0 et 0.12 10.8	13.1 13.5 13.7 14.1 14.6 14.9 0.13 11.4	13.9 14.4 14.7 15.1 15.5 16.0	14.7 15.4 15.7 16.1 16.6 17.0 0.15 12.7
th HRmin = 0.05 Rule 3 with 25/20% TAC-con Btrigger	2500 3184 3500 4000 55000 \$ \$ \$ \$ \$ \$ \$	0.07 11.0 11.5 12.1 13.6 14.8 15.2 chortte 0.07 7.8 8.9	0.08 9.3 10.0 11.1 13.6 14.8 15.1 erm IA 0.08 8.0 9.6	0.09 8.9 10.0 11.3 13.8 14.9 15.1 V 0.09 8.2 10.2	0.1 9.1 10.3 11.7 14.0 15.0 15.2 H 0.1 8.4	0.11 9.4 10.8 12.2 14.4 15.1 15.3 Rtarg 0.11 8.7 11.5	0.12 10.1 11.7 13.2 14.8 15.4 15.5 et 0.12 9.0 12.4	11.5 13.2 14.5 15.5 15.7 15.6 0.13 9.3 13.4	13.1 15.2 16.0 16.3 16.0 15.7 0.14 9.7	15.6 17.7 17.9 17.0 16.3 15.9 0.15 10.1 15.4	2500 3184 4000 4000 5000 2500	0.07 9.6 9.8 9.9 10.3 10.6 11.0 mediu 0.07 7.9	0.08 10.1 10.4 10.5 10.9 11.3 11.7 mterm 0.08 8.3	0.09 10.7 11.0 11.2 11.7 12.1 12.5 12.5 1AV 0.09 8.9	0.1 11.3 11.7 12.0 12.5 12.9 13.3 H 0.1 9.4 10.1	0.11 11.9 12.4 12.7 13.3 13.7 14.1 Rtarg 0.11 10.0	0.12 12.6 13.2 13.5 14.0 14.5 14.9 0.12 10.6 11.5	13.4 14.0 14.4 15.4 15.7 0.13 11.2 12.3	14.2 14.9 15.3 15.8 16.3 16.6 0.14 11.9	14.9 15.9 16.2 16.7 17.1 17.4 0.15 12.5 14.0	Btrigger	2500 3184 3500 4000 5000 8 2500 3184	0.07 9.1 9.2 9.3 9.4 9.5 9.7 0.07 8.2	0.08 9.7 9.8 9.9 10.0 10.2 10.5 rm IA 0.08 8.7	0.09 10.3 10.5 10.5 10.7 11.0 11.3 V 0.09 9.2	0.1 11.0 11.1 11.3 11.5 11.8 12.2 H 0.1 9.7 10.0	0.11 11.6 11.9 12.0 12.3 12.7 13.1 Rtarge 0.11 10.2 10.7	0.12 12.3 12.6 13.2 13.6 14.0 et 0.12 10.8 11.4	13.1 13.5 13.7 14.1 14.6 14.9 0.13 11.4	13.9 14.4 14.7 15.1 15.5 16.0 0.14 12.0 12.9	14.7 15.4 15.7 16.1 16.6 17.0 0.15 12.7 13.8
rule with HRmin = 0.05 Rule 3 with 25/20% TAC-con igger Btrigger	2500 3184 3500 4000 5000 \$ \$ 2500 3184 3500	0.07 11.0 11.5 12.1 13.6 14.8 15.2 hortte 0.07 7.8 8.9 10.1	0.08 9.3 10.0 11.1 13.6 14.8 15.1 erm IA 0.08 8.0 9.6 11.1	0.09 8.9 10.0 11.3 13.8 14.9 15.1 V 0.09 8.2 10.2 12.2	0.1 9.1 10.3 11.7 14.0 15.0 15.2 H 0.1 8.4 10.8	0.11 9.4 10.8 12.2 14.4 15.1 15.3 Rtarg 0.11 8.7 11.5 14.7	0.12 10.1 11.7 13.2 14.8 15.4 15.5 et 0.12 9.0 12.4 16.0	11.5 13.2 14.5 15.5 15.7 15.6 0.13 9.3 13.4 17.4	13.1 15.2 16.0 16.3 16.0 15.7 0.14 9.7 14.3 18.7	15.6 17.7 17.9 17.0 16.3 15.9 0.15 10.1 15.4	2500 3184 300 114 4000 4500 5000 11 2500 3184	0.07 9.6 9.8 9.9 10.3 10.6 11.0 mediu 0.07 7.9 8.1	0.08 10.1 10.4 10.5 10.9 11.3 11.7 mterm 0.08 8.3 8.7	0.09 10.7 11.0 11.2 11.7 12.1 12.5 12.5 1AV 0.09 8.9 9.4	0.1 11.3 11.7 12.0 12.5 12.9 13.3 H 0.1 9.4 10.1	0.11 11.9 12.4 12.7 13.3 13.7 14.1 Rtarg 0.11 10.0 10.7	0.12 12.6 13.2 13.5 14.0 14.5 14.9 0.12 10.6 11.5 11.9	13.4 14.0 14.4 15.4 15.7 0.13 11.2 12.3 12.8	14.2 14.9 15.3 16.3 16.6 0.14 11.9 13.1 13.6	14.9 15.9 16.2 16.7 17.1 17.4 0.15 12.5 14.0 14.6	igger Btrigger	2500 3184 3500 4000 5000 8 2500 3184	0.07 9.1 9.2 9.3 9.4 9.5 9.7 0.07 8.2 8.3	0.08 9.7 9.8 9.9 10.0 10.2 10.5 rm IAV 0.08 8.7 8.8	0.09 10.3 10.5 10.5 10.7 11.0 11.3 V 0.09 9.2 9.4	0.1 11.0 11.1 11.3 11.5 11.8 12.2 H 0.1 9.7 10.0 10.2	0.11 11.6 11.9 12.0 12.3 12.7 13.1 Rtarge 0.11 10.2 10.7	0.12 12.3 12.6 12.8 13.2 13.6 14.0 et 0.12 10.8 11.4 11.6	13.1 13.5 13.7 14.1 14.6 14.9 0.13 11.4 12.1 12.5	13.9 14.4 14.7 15.1 15.5 16.0 0.14 12.0 12.9	14.7 15.4 15.7 16.1 16.6 17.0 0.15 12.7 13.8 14.3
ass rule with HRmin = 0.05 Rule 3 with 26/20% TAC-con Btrigger Btrigger	2500 3184 3500 4000 5000 \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$ \$	0.07 11.0 11.5 12.1 13.6 14.8 15.2         	0.08 9.3 10.0 11.1 13.6 14.8 15.1 erm IA 0.08 8.0 9.6 11.1	0.09 8.9 10.0 11.3 13.8 14.9 15.1 5.1 0.09 8.2 10.2 12.2 14.2	0.1 9.1 10.3 11.7 14.0 15.0 15.2 H 0.1 8.4 10.8 13.4 15.5	0.11 9.4 10.8 12.2 14.4 15.1 15.3 Rtarg 0.11 8.7 11.5 14.7 16.9	0.12 10.1 11.7 13.2 14.8 15.4 15.5 0.12 9.0 12.4 16.0 18.1	11.5 13.2 14.5 15.5 15.7 15.6 0.13 9.3 13.4 17.4 19.4	13.1 15.2 16.0 16.3 16.0 15.7 0.14 9.7 14.3 18.7 20.5	15.6 17.7 17.9 17.0 16.3 15.9 0.15 10.1 15.4 20.2 21.8	2500 3184 4000 4000 5000 2500	0.07 9.6 9.8 9.9 10.3 10.6 11.0 mediu 0.07 7.9 8.1 8.2	0.08 10.1 10.4 10.5 10.9 11.3 11.7 mterm 0.08 8.3 8.7 8.9	0.09 10.7 11.0 11.2 11.7 12.1 12.5 1AV 0.09 8.9 9.4 9.6	0.1 11.3 11.7 12.0 12.5 12.9 13.3 H 0.1 9.4 10.1 10.3 10.7	0.11 11.9 12.4 12.7 13.3 13.7 14.1 Rtarg 0.11 10.0 10.7 11.1	0.12 12.6 13.2 13.5 14.0 14.5 14.9 0.12 10.6 11.5 11.9 12.4	13.4 14.0 14.4 15.7 15.7 0.13 11.2 12.3 12.8 13.4	14.2 14.9 15.3 16.3 16.6 0.14 11.9 13.1 13.6 14.4	14.9 15.9 16.2 16.7 17.1 17.4 0.15 12.5 14.0 14.6 15.5	Btrigger	2500 3184 3500 4000 4500 5000 2500 3184 3500 4000	0.07 9.1 9.2 9.3 9.4 9.5 9.7 0.07 8.2 8.3 8.3	0.08 9.7 9.8 9.9 10.0 10.2 10.5 rm IA 0.08 8.7 8.8 8.9	0.09 10.3 10.5 10.5 10.7 11.0 11.3 V 0.09 9.2 9.4 9.5	0.1 11.0 11.1 11.3 11.5 11.8 12.2 H 0.1 9.7 10.0 10.2 10.4	0.11 11.6 11.9 12.0 12.3 12.7 13.1 Rtargo 0.11 10.2 10.7 10.9 11.2	0.12 12.3 12.6 13.2 13.6 14.0 0.12 10.8 11.4 11.6 12.1	13.1 13.5 13.7 14.1 14.6 14.9 0.13 11.4 12.1 12.5	13.9 14.4 14.7 15.1 15.5 16.0 0.14 12.0 12.9 13.3 14.0	14.7 15.4 15.7 16.1 16.6 17.0 0.15 12.7 13.8 14.3 15.1
-biomass rule with HRmin = 0.05 Rule 3 with 25/20% TAC-con Btrigger	2500 3184 4000 5000 5000 S 2500 3184 4000 4000 4000	0.07 11.0 11.5 12.1 13.6 14.8 15.2 0.07 7.8 8.9 10.1 11.2 11.2	0.08 9.3 10.0 11.1 13.6 14.8 15.1 0.08 8.0 9.6 11.1 12.8 12.6	0.09 8.9 10.0 11.3 13.8 14.9 15.1 V 0.09 8.2 10.2 12.2 14.2 13.9	0.1 9.1 10.3 11.7 14.0 15.0 15.2 H 0.1 8.4 10.8 13.4 15.5	0.11 9.4 10.8 12.2 14.4 15.1 15.3 8.7 11.5 14.7 16.9 16.4	0.12 10.1 11.7 13.2 14.8 15.4 15.5 9.0 12.4 16.0 18.1 17.4	11.5 13.2 14.5 15.5 15.7 15.6 0.13 9.3 13.4 17.4 19.4 18.4	13.1 15.2 16.0 16.3 16.0 15.7 0.14 9.7 14.3 18.7 20.5 19.3	15.6 17.7 17.9 17.0 16.3 15.9 0.15 10.1 15.4 20.2 21.8 20.3	2500 3184 4000 4500 5000 2500 3184 4000	0.07 9.6 9.8 9.9 10.3 10.6 11.0 .07 7.9 8.1 8.2 8.4	0.08 10.1 10.4 10.5 10.9 11.3 11.7 mterm 0.08 8.3 8.7 8.9 9.1	0.09 10.7 11.0 11.2 11.7 12.1 12.5 14V 0.09 8.9 9.4 9.6 9.9 10.2	0.1 11.3 11.7 12.0 12.5 12.9 13.3 H 0.1 9.4 10.1 10.3 10.7 11.0	0.11 11.9 12.4 12.7 13.3 13.7 14.1 Rtarg 0.11 10.0 10.7 11.1 11.6	0.12 12.6 13.2 13.5 14.0 14.5 14.9 0.12 10.6 11.5 11.9 12.4 12.9	13.4 14.0 14.4 15.4 15.7 0.13 11.2 12.3 12.8 13.4 13.9	14.2 14.9 15.3 15.8 16.3 16.6 0.14 11.9 13.1 13.6 14.4 14.9	14.9 15.9 16.2 16.7 17.1 17.4 0.15 12.5 14.0 14.6 15.5 16.0	Btrigger	2500 3184 3500 4000 4500 5000 2500 3184 3500 4000	0.07 9.1 9.2 9.3 9.4 9.5 9.7 0.07 8.2 8.3 8.3 8.4	0.08 9.7 9.8 9.9 10.0 10.2 10.5 10.5 8.8 8.7 8.8 8.9 9.1 9.2	0.09 10.3 10.5 10.5 10.7 11.0 11.3 V 9.2 9.2 9.4 9.5 9.7 9.9	0.1 11.0 11.1 11.3 11.5 11.8 12.2 H 0.1 9.7 10.0 10.2 10.4	0.11 11.6 11.9 12.0 12.3 12.7 13.1 Rtarguestication of the second	0.12 12.3 12.6 12.8 13.2 13.6 14.0 0.12 10.8 11.4 11.6 12.1 12.5	13.1 13.5 13.7 14.1 14.6 14.9 0.13 11.4 12.1 12.5 13.0 13.5	13.9 14.4 14.7 15.1 15.5 16.0 12.9 13.3 14.0 14.6	14.7 15.4 15.7 16.1 16.6 17.0 0.15 12.7 13.8 14.3 15.1 15.7

Median of the real F in the medium term for HCRs without and with a constraint in interannual TAC change. Unshaded cells correspond to the precautionary [Ftarget, Btrigger] or [HRtarget, Btrigger] combinations [P(SSB< Blim)< 5%]. Note: The values for the biomass options are also shown as real F – not harvest rate.

2500

3184

4000

4500

Btrigger 3500 0.07

0.08

0.08 0.09

0.08 0.09

0.08 0.09

# Realised F for all tested rules with Risk3

Rule 1 - F-rule through 0,0 Etar	net
----------------------------------	-----

						•			
	0.1	0.12	0.125	0.14	0.15	0.16	0.17	0.18	0.2
2500	0.10	0.12	0.12	0.14	0.15	0.15	0.16	0.17	0.19
	0.10								
Btrigger 4000	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18
j	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.16	0.18
4500			0.12						
5000	0.09	0.11	0.11	0.13	0.13	0.14	0.15	0.15	0.17

Rule 1 with average constraint Ftarget

						lange				
		0.1	0.12	0.125	0.14	0.15	0.16	0.17	0.18	0.2
	2500	0.10	0.12	0.12	0.14	0.15	0.15	0.16	0.17	0.19
	3184	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18
idel	3500	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.16	0.18
Btrigger	4000	0.09	0.11	0.12	0.13	0.14	0.14	0.15	0.16	0.17
-	4500	0.09	0.11	0.11	0.12	0.13	0.14	0.15	0.15	0.17
	5000	0.09	0.11	0.11	0.12	0.13	0.14	0.14	0.15	0.16

### Rule 1 with 25/20% TAC-constraint

					riarge	L I			
	0.1	0.12	0.125	0.14	0.15	0.16	0.17	0.18	0.2
2500	0.09	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18
3184	0.09	0.11	0.11	0.13	0.14	0.14	0.15	0.16	0.17
<b>eg</b> 3500	0.09	0.11	0.11	0.13	0.13	0.14	0.15	0.16	0.17
Btrigger 4000	0.09	0.11	0.11	0.12	0.13	0.14	0.14	0.15	0.16
4500	0.09	0.10	0.11	0.12	0.13	0.13	0.14	0.15	0.16
5000	0.09	0.10	0.11	0.12	0.12	0.13	0.14	0.14	0.15

# Rule 2 - F-rule with Fmin = 0.05

						rlarge				
		0.1	0.12	0.125	0.14	0.15	0.16	0.17	0.18	0.2
25	500	0.10	0.12	0.12	0.14	0.15	0.15	0.16	0.17	0.19
	184	0.10	0.12	0.12	0.13	0.14	0.15	0.16	0.17	0.19
Btrigger	500	0.10	0.11	0.12	0.13	0.14	0.15	0.16	0.17	0.18
<sup>4</sup>	000	0.10	0.11	0.12	0.13	0.14	0.15	0.15	0.16	0.18
	500	0.09	0.11	0.12	0.13	0.14	0.14	0.15	0.16	0.17
50	000	0.09	0.11	0.11	0.12	0.13	0.14	0.14	0.15	0.16

# Rule 3 with average constraint

Rule 3 - biomass rule going through 0,0 HRtarget

0.09

0.1

0.10 0.11

0.11 0.12

0.08 0.09 0.10 0.11 0.13 0.14 0.15 0.17 0.18 0.08 0.09 0.10 0.11 0.13 0.14 0.15 0.16 0.17

0.12

5000 0.07 0.09 0.10 0.11 0.12 0.13 0.14 0.15 0.15

0.10 0.11 0.12 0.13 0.14 0.16 0.17

0.10 0.11 0.12 0.13 0.14 0.15 0.16

0.13

0.14 0.15 0.16 0.17

0.14

0.15

		inter are	chage (	F	Rtarge	et			
	0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15
2500	0.07	0.09	0.10	0.11	0.12	0.13	0.15	0.16	0.17
J184	0.07	0.08	0.10	0.11	0.12	0.13	0.14	0.15	0.16
Btrigger 4000	0.07	0.08	0.10	0.11	0.12	0.13	0.14	0.15	0.16
1000 A000	0.07	0.08	0.09	0.10	0.11	0.13	0.14	0.15	0.15
4500	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15
5000	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.14

### Rule 3 with25/20% TAC-constraint

		HRtarget								
		0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15
Btrigger	2500	0.08	0.09	0.10	0.11	0.12	0.14	0.15	0.16	0.17
	3184	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.16	0.17
	3500	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16
	4000	0.07	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.16
	4500	0.07	80.0	0.09	0.10	0.11	0.12	0.13	0.14	0.15
	5000	0.07	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.14

# Rule 4 - biomass rule with HRmin = 0.05 HRtarget

		0								
		0.07	0.08	0.09	0.1	0.11	0.12	0.13	0.14	0.15
Btrigger	2500	0.08	0.09	0.10	0.11	0.13	0.14	0.15	0.17	0.18
	3184	0.08				0.12				
	3500	0.08	0.09	0.10	0.11	0.12	0.14	0.15	0.16	0.17
	4000	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.16	0.17
	4500	0.08				0.12				
	5000	0.07	0.09	0.10	0.11	0.12	0.13	0.14	0.15	0.15

# Annex 2\*\*

Following the initial advice concerning the management strategy evaluation of harvest control rule (HCR) options released by ICES on 28September 2018, the Coastal States sent a new request to ICES regarding further evaluation of their selected harvest control rule and LTMS options:

# **Request to ICES concerning a long-term management strategy for Norwegian Spring-Spawning** (Atlanto-Scandian) **Herring**

With basis in the advice released by ICES on 28<sup>th</sup> of September 2018 regarding LTMS for Norwegian Spring Spawning (Atlanto-Scandian) Herring, ICES is requested to evaluate the following LTMS:

- Rule 2 with a Btrigger=Bpa = 3,184,000 tonnes and Fmanagement= 0.14
  - Interannual variation constraint: When the rules would lead to a TAC, which deviates by more than 20% below or 25% above the TAC of the preceding year, the TAC is to be set respectively no more than 20% less or 25% more than the TAC of the preceding year.
  - The TAC constraint shall not apply if the SSB for the year for which the TAC is to be set is forecast to be less or equal to Btrigger.
  - Allowing a maximum of 10% to be banked or borrowed any year. However, borrowing shall not be allowed when the stock is forecast to be under Btrigger at the end of the TAC year.

The above LTMS shall be assessed in relation to how it performs in the short term (2019-2023), medium term (2024-2033) and long term (2034-2053) in relation to:

- Average SSB
- Average yield
- Indicator for year to year variability in SSB and yield
- Risk of SSB falling below B<sub>lim</sub>

In case the above LTMS is consistent with the precautionary approach, ICES is requested to apply the LTMS as basis for the advice for 2019 and onward. However, for 2019, the interannual variation constraints shall not be applied.

To answer the request, simulations were run using the same methods used at WKNSSHMSE – i.e. following the methods described above. The code was updated to include scenarios of banking and borrowing, following the procedure used for North Sea plaice and sole in Brunel and Miller (2013). Banking or borrowing is applied to the TAC after application of the catch constraint. It was simulated to take effect on the TAC from 2018 onwards, with the following scenarios:

- banking 10% in every year from 2018 onwards (scenario 2 in Brunel and Miller, 2013)
- borrowing 10% in every year from 2018 onwards (scenario 3 in Brunel and Miller, 2013)

Four different scenarios were evaluated:

- 1. No banking and borrowing, no catch constraints
- 2. No banking and borrowing, catch constraints
- 3. Banking every year, catch constraints
- 4. Borrowing every year, catch constraints

All scenarios gave a probability of SSB being below  $B_{lim}$  of less than 5% in all years simulated (Table A2.1; Figure A2.1). Including the -20%/+25% catch constraint slightly decreased both the yield and the probability of SSB falling below  $B_{lim}$ . Including banking and borrowing induced only small changes in all performance statistics. Hence, the HCR proposed for the LTMS for NSSH is found to be consistent with the precautionary approach.

# Reference

Brunel, T., and Miller, D.C.M. 2013. An Evaluation of the Impact of Inter-annual Quota Flexibility (Banking and Borrowing) on the Performance of the North Sea Flatfish Long Term Management Plan, June 2013, ICES Headquarters, Copenhagen. ICES CM 2013/ACOM:64. 39 pp.

<sup>\*\*</sup> Version 2: Annex 2 added.

Scenario	Time period	P(SSB < B <sub>lim</sub> )	SSB (kt)	Yield (kt)	Interannual variation in SSB (%)	Interannual variation in Yield (%)
		Max. annual %	median	median	median	median
<ol> <li>No banking or borrowing,</li> </ol>	Short term - 2019–2023	4.3	3622	502	8.1	27.6
<b>no</b> catch constraints	Medium term - 2024–2033	4.6	5049	701	8.5	21.4
	Long term - 2034–2037	3.2	5856	807	8.7	19.5
2. No banking or borrowing,	Short term - 2019–2023	3.8	3681	461	8.3	25
catch constraints	Medium term - 2024–2033	3.9	5474	673	8.9	20
	Long term - 2034–2037	2.4	6183	810	9.2	20
3. Banking every year,	Short term - 2019–2023	3.8	3734	461	8.3	22.5
catch constraints	Medium term - 2024–2033	3.7	5510	675	8.9	18
	Long term - 2034–2037	2.6	6206	810	9.3	18
4. Borrowing every year,	Short term - 2019–2023	3.8	3655	458	8.4	27.5
catch constraints	Medium term - 2024–2033	3.7	5463	673	8.9	22
	Long term – 2034–2037	2.4	6174	808	9.2	22

# Table A2.1. Results from the four scenarios in short, medium and long term.

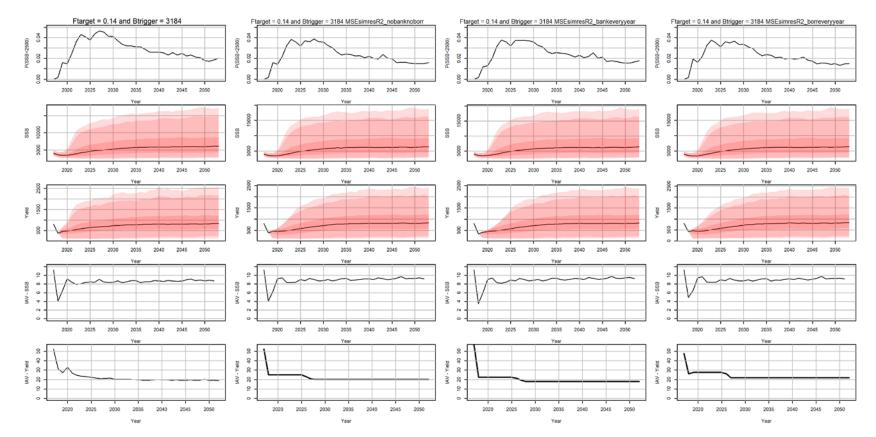


Figure A2.1. Performance statistics for the four scenarios examined: No banking or borrowing or catch constraints (Scenario 1, far left); No banking or borrowing with catch constraints (Scenario 2, centre left); banking every year with catch constraints (Scenario 3, centre right); and borrowing every year with catch constraints (Scenario 4, far right). Results are shown from 2017 to 2053 for: the probability of SSB being below B<sub>lim</sub> (top), SSB (second from top), yield (middle), interannual variation in SSB (second from bottom) and interannual variation in yield (bottom). Solid black lines represent medians, and the SSB and yield plots include confidence ranges (outermost = 95% range).