# Iceland request to evaluate the current management plan for saithe in Icelandic waters, input data, and stock assessment

## Advice summary

ICES has conducted a benchmark assessment and revised biological reference points.

ICES advises that the harvest control rule for saithe in 5.a proposed in the request with a harvest rate of 0.20 as proposed in the request with a MGT $B_{trigger}$ of 61 000 t, is consistent with the precautionary approach and with the ICES MSY approach. However, a harvest rate of 0.19 maximizes median long term yield.

## Request

On 16 October 2018, ICES received the following request from Iceland:

*In two letters dated on the 22nd of April, 2013 the Ministry of Industries and Innovation confirmed the adoption of the current management plans for Icelandic haddock and saithe for the period of 5 years. Additionally, in a letter dated 4th of June 2018 the Ministry notified ICES that the current management plans for haddock and saithe in Icelandic waters would be extend the for one year or until an evaluation of their performance against the management plans objectives has taken place.*

*The Ministry is in a process of consultation with stakeholders and the Marine and Freshwater Research Institute. The result of these consultations may lead to changes in the assessment method, reference points and the form of the HCR.*

*ICES is hereby asked to evaluate the historical performance of the management plans for haddock and saithe against their general aim of maintaining the exploitation rate at the rate which is consistent with the precautionary approach and are in conformity with the ICES MSY approach. ICES is also asked to evaluate the changes in the assessment methods and reference points (Benchmark) if the outcome of the consultations results in any changes. Similarly, to evaluate if the possible changes in the HCR are consistent with the precautionary approach and are in conformity with the ICES MSY approach.*

*The work will be carried out by national experts at the Marine and Freshwater Research Institute with input from managers and stakeholders. The evaluation of the HCR, along with technical documentation on the input data, assessment and reference points will be submitted to ICES for review by the 1st of February 2018. It is expected that the review and the benchmark results will be available before the North Western Working Group (NWWG) meets in April 2019.*

In further correspondence received by ICES on 1 March 2019, it was requested that ICES specifically review the following harvest control rule for saithe:

*In a letter (ANR 18100255/11.02.00) from 16th of October 2018 the Icelandic Ministry of Industries and Innovation requested ICES to evaluate the historical performance of the management plan for saithe against their general aim of maintaining the exploitation rate at the rate which is consistent with the precautionary approach and are in conformity with the ICES MSY approach. ICES was also asked to evaluate possible changes in the assessment methods and estimated reference points.*

*In consultations between scientists from the Marine and Freshwater Institute, stakeholders and the Ministry of Industries and Innovation there was a consensus not to change the current harvest control rule (HCR) for haddock and saithe. Therefore, the Ministry requests ICES to evaluate if the harvest control rule is still consistent with the precautionary approach and in conformity with the ICES MSY-approach. Additionally, ICES is requested to*

*a) Re-evaluate the assessment framework and the harvest control rule for saithe (specified below) given the data and knowledge gathered since 2013.*
*b) If the harvest control rule is found not to meet its objectives to propose changes.*
*c) Report on the probability distribution of the realized harvest rate (HR) given the values of $HR_{MGT}$ = 0.2 for saithe.*

*The management strategy for Icelandic saithe is to maintain the exploitation rate at the rate which is consistent with the precautionary approach and that generates maximum sustainable yield (MSY) in the long term.*

*The annual TAC is set by a harvest control rule. The rule is based on the mean of the TAC in the current year ($TAC_{y-1/y}$) and 20% ($HR_{MGT}$ = 0.2) of the biomass of 4 year and older saithe ($B_{4+,y}$) in the assessment year (y). The TAC for the fishing year y/y+1 (September 1 of year y to August 31 of year y+1) is calculated as follows:*

$$TAC_{y/y+1} = (HR_{MGT} * B_{4+,y} + TAC_{y-1/y}) / 2$$

*If the spawning stock biomass (SSB) falls below 65 000 tonnes (MGT $B_{trigger}$), the harvest control rule dictates that $HR_{MGT}$ shall be reduced linearly to zero based on the ratio of the SSB estimated and MGT $B_{trigger}$, the TAC for the fishing year y/y+1 is then calculated as:*

$$TAC_{y/y+1} = (1-SSB_y/(2 * MGT\ B_{trigger})) * HR_{MGT} * SSB_y/MGT\ B_{trigger} * B_{4+,y} + TAC_{y-1/y} * SSB_y/(2*MGT\ B_{trigger})$$

*When $HR_{MGT}$ is applied the realized harvest rate is expected to vary between 0.12 and 0.32 when following the HCR (ICES 2013a). On average the realized HR should be close to $HR_{MGT}$. As stated above ICES is requested to report on the probability distribution of the realized harvest rate when $HR_{MGT}$ = 0.2.*

This advice deals with the request for saithe. The ICES advice on the requests for haddock is provided separately.

## Elaboration on the advice

### *Benchmark assessment and evaluation of reference points*

ICES has conducted a benchmark assessment in 2019, and has calculated biological reference points (ICES, 2019). The assessment model was not changed. New reference points were estimated as $B_{pa}$ = 61 kt, based on $B_{loss}$, the lowest observed biomass (SSB in 1996 as estimated in the benchmark assessment), and $B_{lim} = B_{pa}/1.4$ = 44 kt. The proposed harvest control rule (HCR) is based not on F, but on a harvest rate (HR) relative to stock biomass of age 4 and older fish ($B_{4+}$) using landing weights. Given this statement, the fishing pressure reference points were estimated for harvest rate rather than fishing mortality, resulting in $HR_{lim}$ = 0.36 and $HR_{pa}$ = 0.28. MSY reference points were also calculated and resulted in $HR_{MSY}$ = 0.20 and MSY $B_{trigger}$ = 61 kt. The 5$^{th}$ percentile of SSB when fishing at $HR_{MSY}$ (without trigger) is lower than $B_{PA}$, therefore $B_{PA}$ is used for MSY $B_{trigger}$.

### *Evaluation of candidate harvest control rule*

The proposed HCR for the Icelandic saithe fishery sets a TAC for the fishing year *y*/*y*+1 based on a harvest rate of 0.2 on the age 4+ biomass in the assessment year *y* ($B_{4+,y}$), modified by the ratio $SSB_y$/MGT $B_{trigger}$ when $SSB_y$ < MGT $B_{trigger}$. Both reference biomass and SSB are estimated on 1 January. The rule includes a stabiliser element, where the final TAC is the mean of the TAC for the current year and the outcome of the HCR ($HR_{MGT}$*$B_{4+}$). ICES considers the rule to be precautionary as it results in less than 5% probability of SSB < $B_{lim}$ in the short, medium, and long term. In the long-term simulations of the management plan, a harvest rate of 0.19 was found to maximize median yield (Figure 1), though there is less than 2% difference in yield compared to a harvest rate of 0.20.

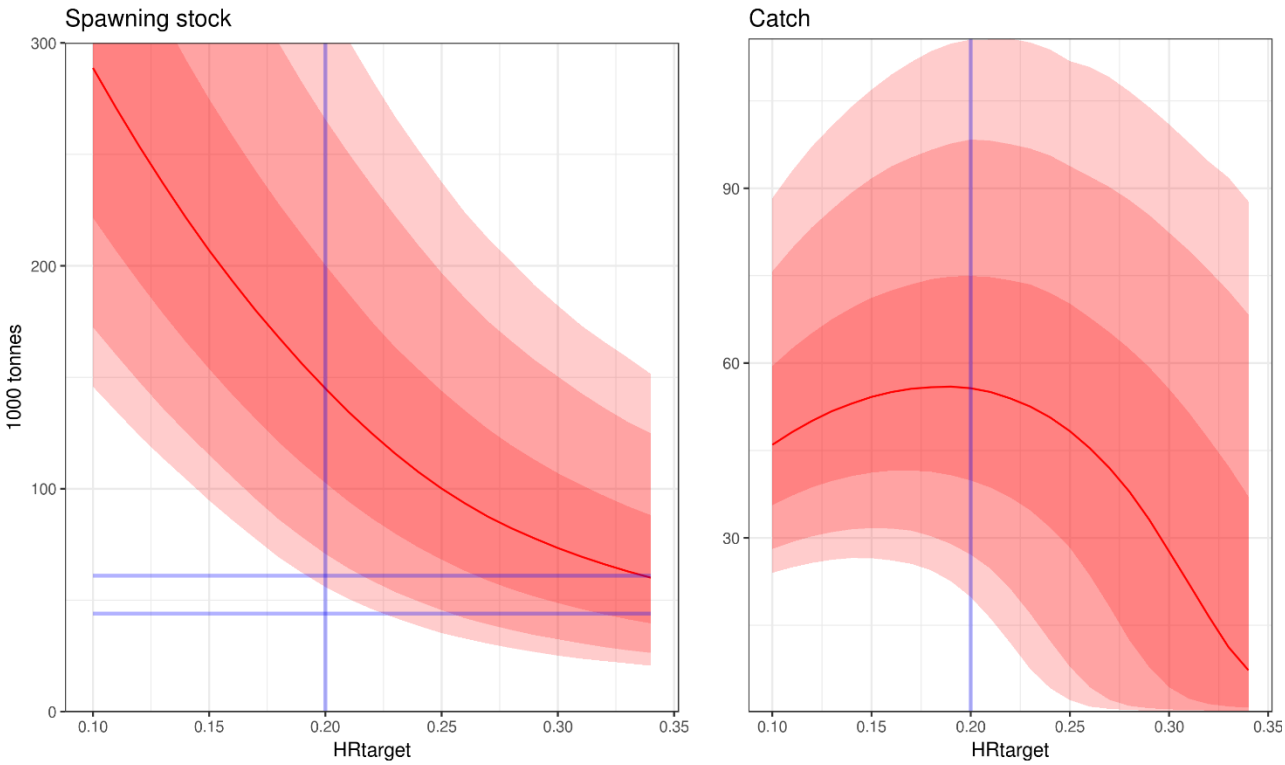


**Figure 1** Saithe in 5.a. Equilibrium catch curve (left panel) and corresponding SSB (right panel) as a function of harvest rate (HR). In both panels, the solid red curves indicate the median of the distribution and the ribbons 5, 10, 25, 75, 90 and 95 percentiles. The vertical line is $HR_{MGT}$ (0.2) and the horizontal lines $B_{pa}$ and $B_{lim}$.

## Basis of the advice

### Background

The request is based on the work of an ad-hoc group of managers, stakeholders, and scientists from the Marine and Freshwater Research Institute (MFRI); initiated by the Icelandic Ministry of Industries and Innovation in the summer of 2018. The objective of the group was to investigate the performance of currently implemented harvest control rules for haddock and saithe, and to provide any necessary revisions to ensure their conformity with the precautionary approach and ICES MSY framework, and that a high long-term sustainable yield is maintained.

The HCR defined in the request is based on a harvest rate approach using a reference biomass for saithe at age 4 and older ($B_{4+}$). The rule was first evaluated in 2013 (Hjörleifsson and Björnsson, 2013) and subsequently implemented in the same year by the government of Iceland.

ICES set up a workshop (ICES, 2019) to evaluate the HCR, and included a review of the stock assessment methodology and reference points.

### Results and conclusions

The results of simulations of the proposed HCR in terms of key population metrics (recruitment, yield, harvest rate, spawning biomass, and the reference biomass of age 4+ saithe) are given in Figure 2. The future dynamics are expected to be similar to those observed historically.

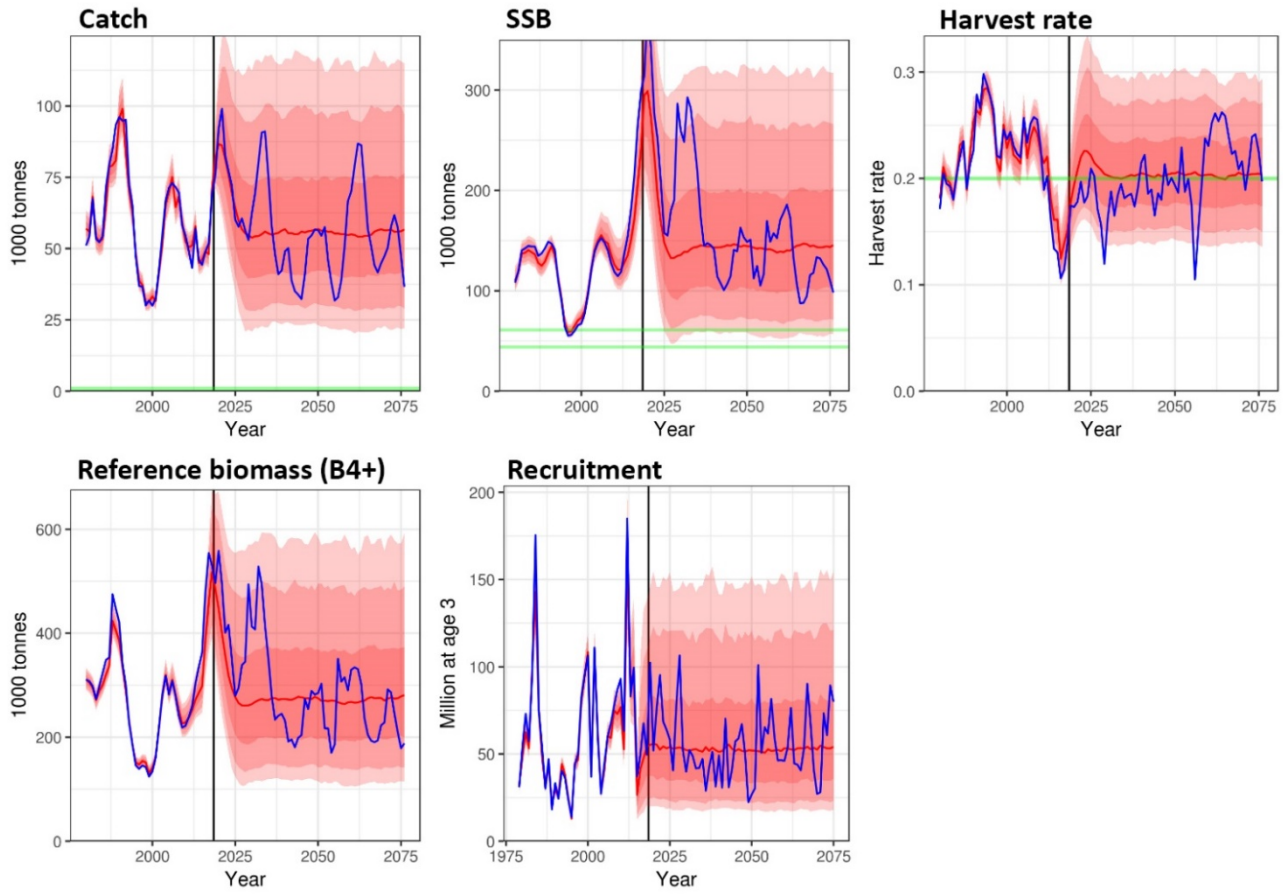


**Figure 2** Saithe in 5.a. Simulation results for $HR_{MGT}$ (0.2): Projected catches, spawning stock biomass (SSB), harvest rate relative to $B_{4+}$ reference biomass, and recruitment. Both reference biomass and SSB are estimated on 1 January. The red lines are medians and the ribbons 5, 10, 25, 75, 90, and 95 percentiles. Green horizontal lines represent and $B_{lim}$ and $B_{pa\ on}$ the SSB plot and HRMGT on the harvest rate plot. The blue lines represent an example iteration.

With an HR = 0.2, annual probabilities of SSB < $B_{lim}$ are less than 5% in all years. Maximum median catch occurs at HR = 0.19 but HR in the range 0.17–0.21 lead to less than 2% difference compared to the maximum. The maximum probability of SSB<$B_{lim}$ in the future in any single year (0.04) occurs in the period 2027–2028, resulting from the current large stock size and TAC. The TAC stabiliser also prevents appropriate reductions in fishing pressure if poor recruitment leads to a declining stock.

The distributions of 4+ biomass ($B_{4+}$), SSB, harvest rates, and catches expected to result from the HCR defined in the request with a harvest rate of 0.20 and MGT $B_{trigger}$ of 61 kt ($B_{pa}$) are shown in Figure 2 and Table 1. These distributions should be used in the future to check that realised ranges are in line with expectations. If future observed values are found outside the range illustrated, this would indicate that there is a need to re-evaluate the assumptions of the simulations.

**Table 1** Saithe in 5.a. Median, 5th and 95th percentiles of the projected reference biomass ($B_{4+}$) , SSB, harvest rate, and catches for $HR_{MGT}$ (=0.2)

| Measure | $B_{4+}$ (in kt) | SSB (in kt) | Realised harvest rate (HR) | Catches (in kt) |
|---|---|---|---|---|
| Median | 279 | 144 | 0.20 | 56 |
| 5$^{th}$ percentile | 115 | 57 | 0.14 | 22 |
| 95$^{th}$ percentile | 585 | 317 | 0.29 | 115 |

The inclusion of the MGT $B_{trigger}$ is considered necessary to reduce the risk of depletion of the stock in periods of poor recruitment. If the SSB declines below $B_{pa}$ (=MSY $B_{trigger}$), the rate of recovery is improved if the HR is reduced when the stock is below MGT $B_{trigger}$. Under normal circumstances this MGT $B_{trigger}$ (set at $B_{pa}$) should only be encountered very rarely (Figure 2).

**Methods**

The current assessment model was considered fit for purpose during the benchmark.

A Management Strategy Evaluation (MSE) was conducted for saithe in 5.a. The operating model, which generates the "true" future populations in the simulations, was conditioned on the ICES stock assessment. A short-cut approach to generating assessment error was used (ICES, 2013b).

No short-term forecast is required when applying the HCR, as the TAC for the fishing year *y*/*y*+1 is based on the harvest rate as a proportion of the reference biomass in the assessment year *y*. The spawning-stock biomass in the assessment year is used as a trigger to modify the harvest rate used in the HCR. The assessment error of the reference stock biomass was assigned a CV=0.22, based on analytical retrospective runs. The assessment error was auto-correlated to emulate observed sequential periods of over- or under-estimation of stock biomass.

Implementation error on the total catch was included in the simulations to account for observed transfers of quota from one species to another. It was assigned a CV=0.07, based on the time-series of quota transfers among species. Similar to the assessment error, the implementation error was auto-correlated to emulate observed periods of catches deviating from the TAC. In recent years, the tendency has been to transfer quota from saithe to other species.

The selection pattern used is the same as that estimated within the model. Recruitment was projected using a log-normal distribution, based on the distribution of CVs and autocorrelations estimated by the assessment model with MCMC resampling. Mean weight and maturity at age was based on the average of last 10 years. Stochasticity in weight around this value was implemented as a log-normal year factor with CV=0.13 and $\rho = 0.5$. Maturity at age, based on the survey in March, was fixed in the simulations. The spawning stock and reference biomass are compiled based on catch weights that are not available at the time of assessment, but are predicted from last year's catch weights and survey weights in the same year.

## Sources and references

Hjörleifsson, E. and Björnsson, H. 2013. Report of the evaluation of the Icelandic saithe management plan, ICES CM 2013/ACOM:61. 70 pp.

ICES 2013a. Request from Iceland to ICES to evaluate the long-term management plan and harvest control rule for Icelandic saithe. ICES advice 2013, Book 2.

ICES. 2013b. Report of the Workshop on Guidelines for Management Strategy Evaluations (WKGMSE), 21–23 January 2013, ICES HQ, Copenhagen, Denmark. ICES CM 2013/ACOM:39. 128 pp.

ICES. 2019. Workshop on the benchmark assessment and management plan evaluation for Icelandic haddock and saithe (WKICEMSE). ICES Scientific Reports. 1:10. 107 pp. http://doi.org/10.17895/ices.pub.5091

*Recommended citation:* ICES. 2019. Saithe in 5.a. Evaluation of the current management plan for saithe in Icelandic waters, input data, and stock assessment. *In* Report of the ICES Advisory Committee, 2019. ICES Advice 2019, sr.2019.08, https://doi.org/10.17895/ices.advice.4896