Iceland request to evaluate the current management plan for haddock 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 haddock in 5.a proposed in the request is not considered precautionary. If the harvest rate is reduced from 0.4 to 0.35 and MGT $B_{trigger}$ is modified to 49 400t (=B_{pa}), the HCR would be consistent with both the precautionary principle and the ICES MSY approach.

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 haddock:

> *In a letter (ANR18100255/11.02.00) from 16th of October 2018 the Icelandic Ministry of Industries and Innovation requested ICES to evaluate the historical performance of the management plan for haddock against the 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, apart from a revision of the management trigger from B_{lim} to B_{pa}. 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*

1. *Re-evaluate the assessment framework and the harvest control rules for haddock (specified below) given the data and knowledge gathered since 2013.*
2. *If the harvest control rule is found not to meet its objectives to propose changes.*
3. *Report on the probability distribution of the realized harvest rate (HR) given the values of HR_{MGT} = 0.4 for haddock.*

The management strategy for Iceland haddock 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 HCR is applied to calculate the annual total allowable catch (TAC) based on 40% (HR_{MGT} = 0.4) of the biomass of 45cm and larger haddock in the advisory year ($B_{45cm+,y+1}$). 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:

$$TAC_{y/y+1} = HR_{MGT} * B_{45cm+,y+1}$$

If the spawning stock biomass (SSB) falls below 64 800 tonnes (MGT Btrigger), the harvest control rule dictates that HRMGT shall be reduced linearly to zero based on the ratio of the SSB estimated and MGT Btrigger, the TAC for the fishing year y/y+1 is then calculated as:

$$TAC_{y/y+1} = HR_{MGT} * SSB / MGT\ B_{trigger} * B_{45cm+,y+1}$$

When HRMGT is applied the realized harvest rate is expected to vary between 0.29 and 0.57 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} = 0.4.

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

Elaboration on the advice

To answer the request ICES has conducted a benchmark assessment and calculated biological reference points, and evaluated the HCR based on these.

Benchmark assessment and evaluation of reference points

The benchmark assessment resulted in changes in the assessment method that are described in the methods section and updated reference points. This has resulted in B_{lim} = 35.5 kt, based on B_{loss}, the lowest observed biomass (SSB in 1987 as estimated in the benchmark assessment), and $B_{pa} = B_{lim}*1.4$ = 49.4 kt. The proposed harvest control rule (HCR) is based not on F, but on a harvest rate (HR) relative to stock biomass of fish larger than 45 cm (45+ cm). Given this statement, the fishing pressure reference points were estimated for harvest rate rather than fishing mortality, which resulted in HR_{lim} = 0.63 and HR_{pa} = 0.50. MSY reference points were also calculated and resulted in HR_{MSY} = 0.35 and MSY $B_{trigger}$ = 49.4 kt.

Evaluation of candidate harvest control rule

The proposed HCR for the Icelandic haddock fishery, which sets a TAC for the fishing year *y*/*y*+1 (September 1 of year *y* to August 31 of year *y*+1) is based on a harvest rate of 0.4 on the 45+ cm biomass in the advisory year *y*+1 ($B_{ref,y+1}$), modified by the ratio SSB_{y+1}/MGT $B_{trigger}$ when SSB_{y+1} < MGT $B_{trigger}$. Both reference biomass and SSB are estimated at spawning time April-May. This HCR is not considered precautionary, as it results in higher than 5% probability of SSB < B_{lim} in the medium and long term. In both the short and long term, a harvest rate of 0.35 with a $B_{trigger} = B_{pa}$ maximizes median yield (Figure 1) while still being precautionary. A HCR with HR_{msy} of 0.35 and MGT $B_{trigger}$ = 49.4 kt was determined, therefore, to conform to the ICES MSY approach.

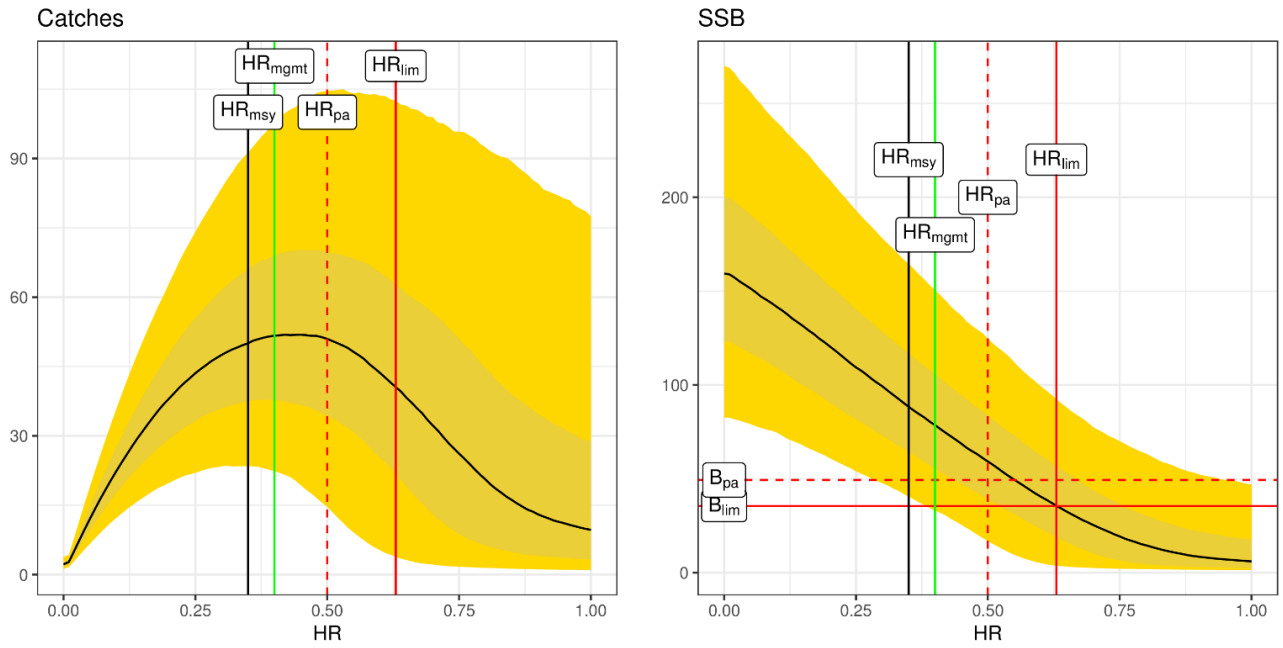

Figure 1 Haddock in 5.a. Equilibrium catches (kt, left panel) and corresponding SSB (kt, right panel) as a function of harvest rate (HR) and a fixed $B_{trigger}$ at 49.4 kt. In both panels, the solid black curves indicate the median of the distribution and the yellow ribbons 5th and 95th percentiles. The vertical lines are HR_{MSY} (=0.35), the currently implemented HR (green, HR_{MGMT}=0.4) and the red vertical lines are the HR PA reference points. The red horizontal lines are the biomass PA reference points.

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 to maintain a high long-term sustainable yield.

The HCR defined in the request is based on a harvest rate approach using a reference biomass for haddock at 45 cm and above ($B_{ref,y+1}$). The rule was first evaluated in 2013 (Björnsson, 2013) and subsequently implemented in the same year by the government of Iceland.

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

Results and conclusions

The results of simulations of the HCR in terms of key population metrics (recruitment, yield, harvest rate, spawning biomass, and the reference biomass of 45+ cm haddock, $B_{ref,y}$) are given in Figure 2. The future dynamics are expected to be similar to those observed historically; however, past exploitation rates have been higher than those anticipated under the proposed HCR. Regardless, this is expected to result in a similar SSB as estimated historically because the proportion mature at age in the stock has decreased in recent years.

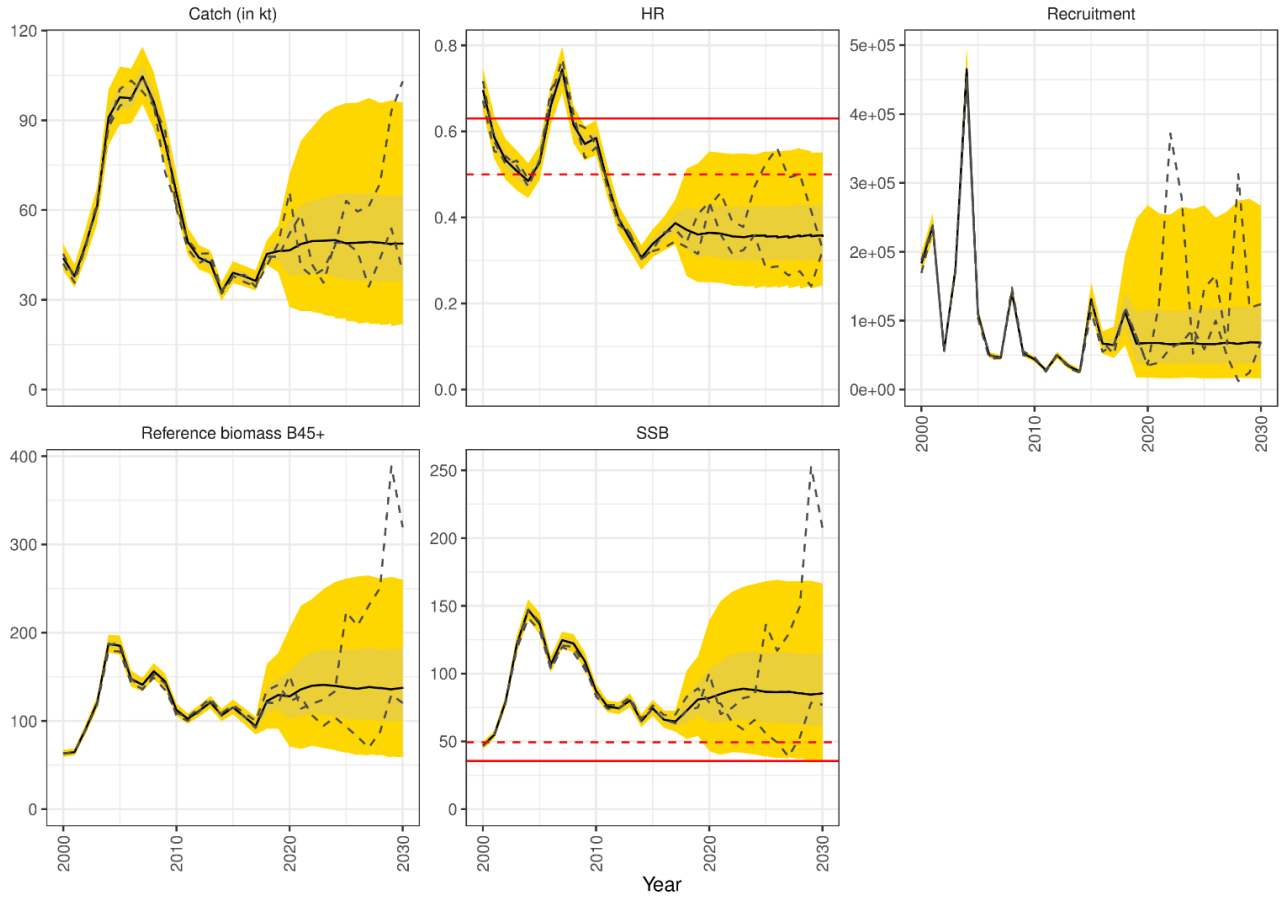

Figure 2 Haddock in 5.a. Simulation results for HR_{MGMT} (0.35). Projected catches, spawning stock biomass, harvest rate relative to $B_{ref,y+1}$, reference biomass, and recruitment. Both reference biomass and SSB are estimated at spawning time April-May. The black solid lines are medians and the yellow bands cover from the 5th to the 95th percentile. Solid and dashed red horizontal lines represent the limit and PA reference points, respectively, for SSB and harvest rate. The black dashed lines represent two example iterations.

With an HR = 0.35, annual probabilities of SSB < B_{lim} are less than 5% in all years. Higher HRs would not be possible without the probability of SSB < B_{lim} exceeding 5% (Table 1). There is only a marginal reduction in median catch (2%) compared to fishing at HR_{MGT} = 0.4, while the lower HR results in a larger SSB (see Figure 1).

Table 1 Haddock in 5.a. Long term projected SSB and catches for the proposed HR_{MGT} (0.35) and the previous HR management target (0.4).

HR management target used in the HCR	Median SSB (in kt)	5th percentile SSB (in kt)	Median Catches (in kt)
HR= 0.35	85.2	36.5	49.1
HR = 0.40	75.2	30.6*	50.1

* indicates SSB values lower than B_{lim} (35.5 kt).

The distributions of 45+ cm biomass ($B_{ref,y}$), SSB, harvest rates, and catches expected to result with the proposed HCR are shown in Figure 2 and Table 2. These distributions should be used in the future to check that realised ranges are compatible with expectations. If future observed values were to go outside the range illustrated, this would indicate that there is a need to re-evaluate the assumptions of the simulations.

Table 2 Haddock in 5.a. Long term median, 5th and 95th percentiles of the projected reference biomass, SSB, realised harvest rate, and catches for a revised HR_{MGT} (0.35)

Measure	$B_{ref,y+1}$ (in kt)	SSB (in kt)	Realised harvest rate (HR)	Catches (in kt)
Median	136.0	85.2	0.36	49.1
5th percentile	59.1	36.5	0.23	21.4
95th percentile	261.0	168.0	0.56	97.0

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 $B_{trigger}$. The simulation shows a 14% probability of having biomass below MGT $B_{trigger}$ (Figure 2).

Methods

The assessment method was updated during this benchmark. The previous assessment model was based on an ADAPT-type model. The new assessment model is a statistical catch at age model using the two previously used survey series (the Icelandic spring and autumn groundfish surveys). The assessment results from the new model have similar characteristics as the previous assessments apart from the estimated spawning stock biomass. This change in the SSB is because the assessment now incorporates natural and fishing mortality before spawning, which occurs from April to the end of May. Previously it was assumed in the assessment that spawning took place at the beginning of the year.

A Management Strategy Evaluation (MSE) was conducted for haddock in 5.a. The operating model, which generates the "true" future populations in the simulations, was conditioned on the ICES stock assessment. 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.

A short cut approach to generating assessment and forecast error was used (ICES, 2013b). The assessment error of the reference 45+ cm stock biomass was assigned a CV=0.2, based on the perceived error in the stock assessment. The assessment error was auto-correlated to emulate observed sequential periods of over- or under-estimation of stock biomass.

Density dependence in growth was accounted for in the simulations. Maturity at age in the projections was based on the relationship between proportion mature and stock weights. In contrast with the 2013 MSE for haddock, the proportion mature by stock weight has been considerably lower in most recent years. This is probably connected to recent changes in the distribution of the stock (more northerly, into colder water). This was taken into account in the MSE by only using the observations from 2013 to 2018 to simulate future proportion mature.

The implementation error on the total catch was included into 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.

Sources and references

Björnsson, H. 2013. Report of the evaluation of the Icelandic haddock management plan. ICES CM 2013/ACOM:59.

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

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