Iceland request for evaluation of a harvest control rule for tusk in Icelandic waters

Advice summary

ICES advises that the proposed harvest control rule with F_{MGT} = 0.23 and MGT $B_{trigger}$ = 4800 tonnes is consistent with both the precautionary approach and conforms with the ICES MSY framework.

Request

ICES received the following request from Iceland:

The Government of Iceland is in the process of re-evaluating the management plans for ling and tusk in Icelandic waters. The management strategy for these stocks 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 in part with the adoption of a management plan.

Part of the management plans is the adoption of harvest control rule (HCR) for setting annual total allowable catch (TAC). The HCR adopted should be precautionary and in accordance with the ICES MSY approach. The current management plans for ling and tusk were first evaluated by ICES before the 2017/2018 fishing year and were found to be consistent with the precautionary approach and in conformity with the ICES MSY framework.

The Government of Iceland requests ICES to evaluate whether the proposed harvest control rules are in accordance with its objectives, given current ICES definition of reference points or any re-evaluation of those points that may occur in the process. Additionally, the evaluation should include review of input data and the applied assessment methodology. It is expected that the ICES advice for the 2022/2023 fishing year for ling, tusk, plaice and Atlantic wolfish be based on the above mentioned HCRs.

In further correspondence received by ICES, it was requested that ICES specifically review the following harvest control rule for tusk:

The HCR is applied to calculate the annual total allowable catch (TAC) based on a forecast from the assessment model with a target fishing mortality on the ages 7 to 10, F_{MGT}, set as 0.23. The TAC for the fishing year y/y+1 (September 1 of year y to August 31 of year y+1) is then calculated from the projected catch for the upcoming fishing year.

If the spawning stock biomass (SSB) falls below 4 800 tonnes (MGT $B_{trigger}$), the harvest control rule dictates that F_{MGT} shall be reduced linearly to zero based on the ratio between the SSB estimated and MGT $B_{trigger}$.

Elaboration on the advice

To answer the request ICES conducted a benchmark assessment and calculated biological reference points, and evaluated the proposed HCR.

Benchmark assessment and evaluation of reference points

The benchmark assessment resulted in changes in the assessment method (described in the Methods section) and updated reference points. The revised reference points are presented in Table 1.

Table 1 Previous and revised ICES reference points for tusk in Division 5.a and 14 following the benchmark. Biomass values in tonnes.

Framework	Reference point	Previous value	Revised value	Revised technical basis
MSY Approach	MSY $B_{trigger}$	5480	4800	B_{pa}
	F_{MSY}	0.23	0.23	Limited by F_{p05}, maximum F at which the probability of SSB falling below B_{lim} is <5%
Precautionary Approach	B_{lim}	3940	3400	$B_{pa} \times e^{-1.645 * \sigma B}$, using the default $\sigma_B = 0.2$
	B_{pa}	5480	4800	B_{loss} (SSB in 2016)
	F_{lim}	0.41	0.44	Fishing mortality that in stochastic equilibrium will result in median SSB at B_{lim}.
	F_{pa}	0.27	0.23	F_{p05}, maximum F at which the probability of SSB falling below B_{lim} is <5%
Management plan	MGT $B_{trigger}$	6240	4800	No lower than MSY $B_{trigger}$
	F_{MGT}	-*	0.23	No higher F_{MSY}

* The previously used HCR was based on a harvest rate (HR) relative to a stock reference biomass, so no F_{MGT} was used.

Evaluation of the HCR

Long term simulations accounting for potential advice error indicate that an HCR, with $F_{MGT} = 0.23$ and MGT $B_{trigger} = 4800$ tonnes, is consistent with both the precautionary approach and conforms with the ICES MSY framework. SSB is compared to MGT $B_{trigger}$ at the beginning of the advice year in the forecast. F_{MGT} is based on F_{MSY}, and MGT $B_{trigger}$ is based on MSY $B_{trigger}$. F_{MSY} is limited by F_{p05}.

Basis of the advice

Background

Under the Memorandum of Understanding between Iceland and ICES, tusk is a stock for which Iceland expects advice from ICES. Tusk has been previously evaluated by the ICES Working Group on Biology and Assessment of Deep-sea Fisheries Resources (WGDEEP).

A request for evaluation was submitted to ICES from the Icelandic Ministry of Industries and Innovation in the autumn of 2021. An evaluation of input data, methods for assessment and reference points took place in February–April 2022.
A further request to ICES was submitted in April 2022 with more specific details on the proposed HCR. The evaluation ensured that the HCR conforms with the precautionary approach and ICES MSY framework.

The HCR defined in the request is based on the ICES advice rule, which applies a target F at or below F_{MGT}. The target F is decreased proportionately according to the ratio of SSB to MGT $B_{trigger}$ when SSB is lower than MGT $B_{trigger}$. There is no additional action below B_{lim}.

Results and conclusions

The results of simulations of the HCR in terms of equilibrium yield and SSB for a range of F values are given in Figure 1.

With a fishing mortality (F) of 0.23, annual probabilities of SSB < B_{lim} are less than 5% in all years. Higher F results in a >5% probability of SSB < B_{lim} (Table 2), but F may range down to 0.18 while maintaining 95% of MSY. Median catch values only increase marginally (1%) at slightly higher F values (F = 0.26), but these correspond to a 10% probability of SSB dropping below B_{lim} (see Figure 1). The ranges of SSB, realized Fs, and catches expected to result from HCRs with Fs ranging from 0.18 to 0.23 are shown in Table 2. These ranges should be used in the future to check that realized ranges are compatible with expectations. If future observed values were to go outside the ranges illustrated, this would indicate that there is a need to re-evaluate the assumptions of the simulations.

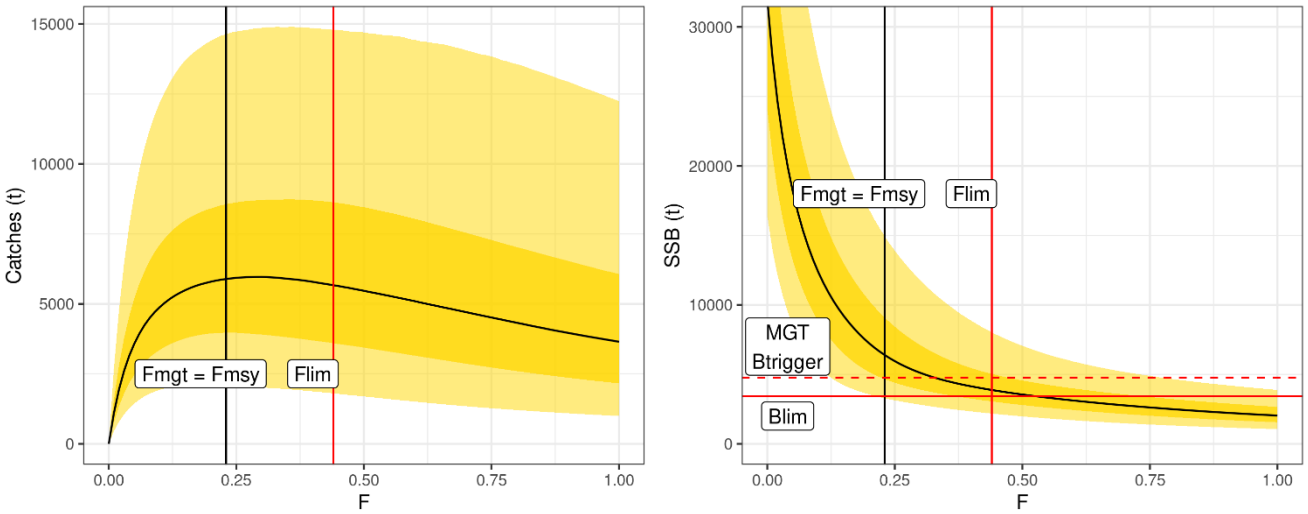

Figure 1 Tusk in divisions 5.a and 14. Equilibrium catches (in tonnes, left panel) and corresponding SSB (in tonnes, right panel) as a function of fishing mortality implemented in the HCR. In both panels, the solid curves indicate the median of the distribution and the ribbons the 5th and 95th and 25th and 75th percentiles. The black vertical line corresponds with $F_{MGT} = F_{MSY}$ (0.23). The red vertical line corresponds with F_{lim}. The dashed and solid red horizontal lines are MGT $B_{trigger}$ (4800 tonnes) and B_{lim} (3400 tonnes), respectively.

Table 2 Tusk in divisions 5.a and 14. Long-term median values, and 90% confidence intervals, of the projected catches, realized Fs, and SSB for alternative F values (0.18 to 0.23) applied in the HCR with MGT $B_{trigger}$ = 4800 tonnes (t).

F	Catches (in t)	Realized F	SSB (in t)
0.18	5695 (2107–14 151)	0.18 (0.12–0.26)	7911 (3778–18 318)
0.23	5888 (2082–14 622)	0.22 (0.14–0.32)	6396 (3283–14 937)

Methods

Benchmark assessment

A statistical catch-at-age model spanning ages 1–10+ was fitted using survey indices from the groundfish trawl surveys Spring IS-SMB [G3239] – Marsrall, and Autumn IS-SMH [G4493] – Haustrall, as well as a spring gillnet survey [N2702] in Iceland (ICES, 2022). The assessment model used is the State space Assessment Model (SAM) described in Nielsen and Berg (2014) and Albertsen and Trijoulet (2020). The model runs from 1979 onwards and ages 1 to 10 are tracked by the model, treating age 10 as a plus group. Observations in SAM are assumed to arise from a multivariate normal process with an expected value derived from the model. Patterns in the residuals were treated by including autocorrelation between ages in autumn survey residuals. The previously used Gadget model has been replaced with the SAM modelling framework as the assessment is more stable over time. Reliable data on catch composition (age and length) are unavailable for years prior to 1995. For those years total catch by weight was used to inform on the catch levels.

HCR simulation

A shortcut Management Strategy Evaluation (MSE) was conducted for tusk in divisions 5.a and 14 using eqSim software (ICES, 2014, 2015). The operating model, which generates the "true" future populations in the simulations, was conditioned on the ICES stock assessment. Future selection, maturity, and weight patterns were set by resampling values from the last 10 years. Recruitment was projected using a log-normal distribution conditioned on the historical residuals, mean recruitment over the historical period (excluding the first 12 years), and autocorrelations estimated from the assessment outputs. Recruitment impairment was assumed to occur when SSB fell below the breakpoint of a hockey-stick recruitment function, set as B_{lim}. A short-cut approach to generating assessment and forecast error was used (ICES, 2013). The advice error of the fishing mortality was assigned a CV = 0.212, based on the default error suggested by ICES (2015). The advice error was auto-correlated to emulate observed sequential periods of over- or under-estimation of stock biomass using the default value of 0.423. F_{MGT} values ranging from 0 to 1 were applied with 2001 simulations per F value to estimate uncertainty of long-term equilibrium results resulting from each F value.

The overall scale of model results, including SSB (t), F, and recruitment at age 3, are very similar between the previously used Gadget model and the SAM model (Figure 2), but the most recent estimates of SSB generated by SAM are lower than those produced by the Gadget model. Recruitment estimates have higher variability than those produced by the Gadget model.

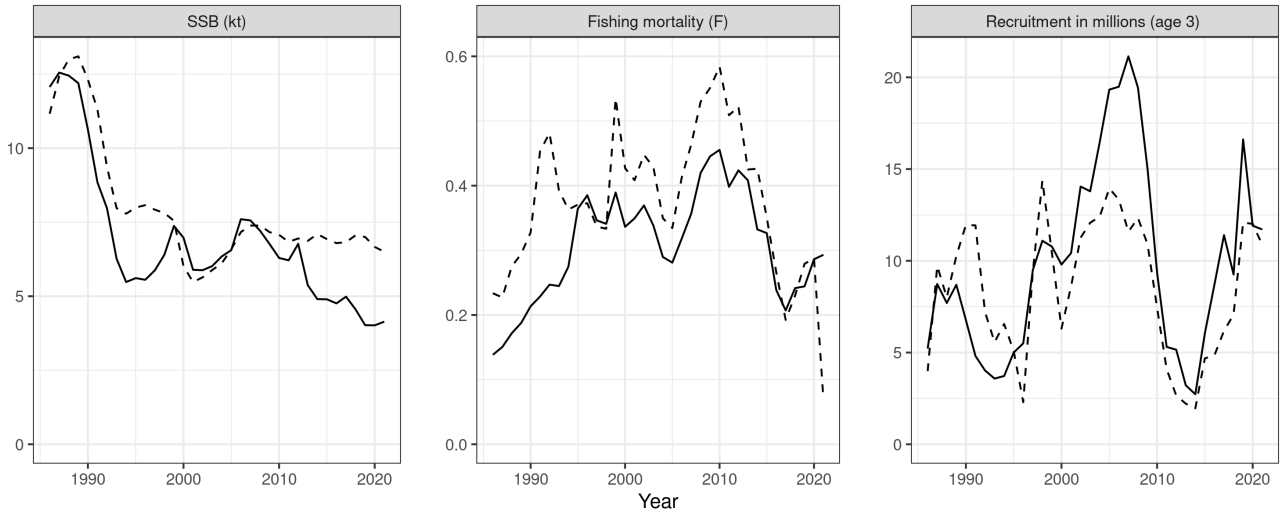

Figure 2 Tusk in Division 5.a and 14. Comparison of SSB, fishing mortality, and recruitment (age 3) estimates from the previously used Gadget assessment (dashed) with those produced by the SAM model (black line).

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