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

Advice summary

ICES advises that the proposed harvest control rule with, F_{MGT} = 0.30 and MGT $B_{trigger}$ = 11 100 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 ling:

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 8 to 11, F_{MGT}, set as 0.30. 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 catch projection for the fishing year.
If the spawning stock biomass (SSB) falls below 11 100 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 ling in Division 5.a following the benchmark. Biomass values in tonnes.

Framework	Reference point	Previous value	Revised value	Revised technical basis
MSY Approach	MSY $B_{trigger}$	9930	11 100	B_{pa}
	F_{MSY}	0.28	0.30	F that produces MSY in the long term
Precautionary Approach	B_{lim}	7090	9000	B_{loss} (SSB in 1993)
	B_{pa}	9930	11 100	$B_{lim} \times e^{1.645 * \sigma B}$, using the default $\sigma_B = 0.2$
	F_{lim}	0.70	0.95	Fishing mortality that in stochastic equilibrium will result in median SSB at B_{lim}.
	F_{pa}	0.41	0.62	F_{p05}, maximum F at which the probability of SSB falling below B_{lim} is <5%
Management plan	MGT $B_{trigger}$	9930	11 100	No lower than MSY $B_{trigger}$
	F_{MGT}	*	0.30	No higher than 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 ICES advice rule

Long term simulations accounting for potential advice error indicate that an HCR, with $F_{MGT} = 0.30$ and MGT $B_{trigger}$ = 11 100 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 $B_{trigger}$.

Basis of the advice

Background

Under the Memorandum of Understanding between Iceland and ICES, ling is a stock for which Iceland expects advice from ICES. Ling 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 0.30, catch is maximized while probabilities of SSB < B_{lim} remain less than 5% in all years. As the yield curve has a flat peak, F values ranging from 0.19 to 0.56 are expected to maintain 95% of the catch at MSY while maintaining SSB above B_{lim} with a probability of 95% or greater (see Figure 1). The ranges of SSB, Fs, realized Fs, and catches expected to result from HCRs with Fs ranging from 0.19 to 0.56 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.

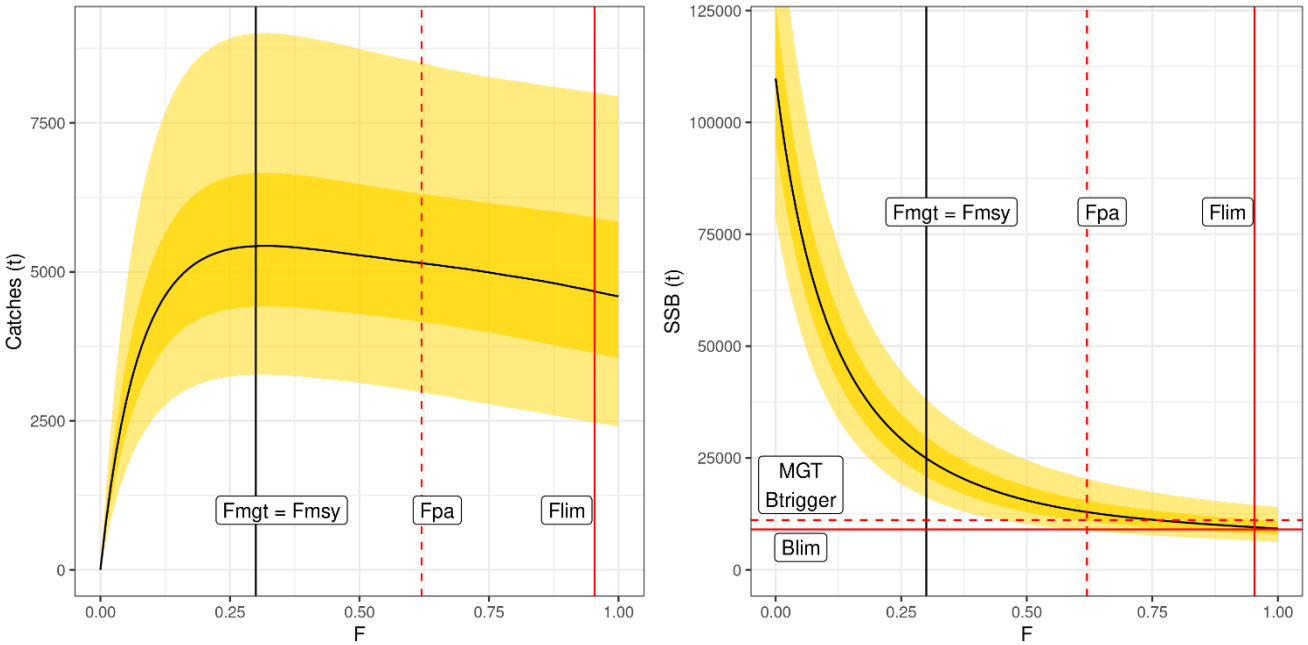

Figure 1 Ling in Division 5.a. Equilibrium catches (in tonnes, left panel) and corresponding SSB (in tonnes, right panel) as a function of fishing mortality implemented in the HCR. In both panels, the solid curves indicate the median of the distribution and the ribbons the 5th and 95th and 25th and 75th percentiles. The black vertical line corresponds with F_{MGT} (0.30). Red vertical lines correspond with F_{p05} (dashed) and F_{lim} (solid). The dashed and solid red horizontal lines are MGT $B_{trigger}$ (11 100 tonnes) and B_{lim} (9 000 tonnes), respectively.

Table 2 Ling in Division 5.a. Long-term median values, and 90% confidence intervals, of the projected catches, realized Fs, reference biomass, and SSB for alternative F values (0.19 to 0.56) applied in the HCR with MGT $B_{trigger}$ = 11 100 tonnes.

F	Catches (in t)	Realized F	SSB (in t)
0.19	5183 (3122–8597)	0.19 (0.13–0.28)	36 633 (24 521–54 682)
0.3	5435 (3274–8998)	0.30 (0.20–0.44)	24 928 (16 185–38 120)
0.4	5389 (3232–8925)	0.40 (0.27–0.59)	19 122 (12 273–29 775
0.56	5210 (3063–8619)	0.55 (0.39–0.79)	14 048 (9401–22 203)

Methods

Benchmark assessment

A statistical catch-at-age model spanning ages 2–12+ 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 2 to 12 are tracked by the model, treating age 12 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, spring, and gillnet 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 1993. 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 ling in Division 5.a 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, a mean

recruitment over the historical period excluding values from 2004 through 2010, 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), fishing mortality, and recruitment at age 3, are very similar between the previously used Gadget model and the SAM model (Figure 2).

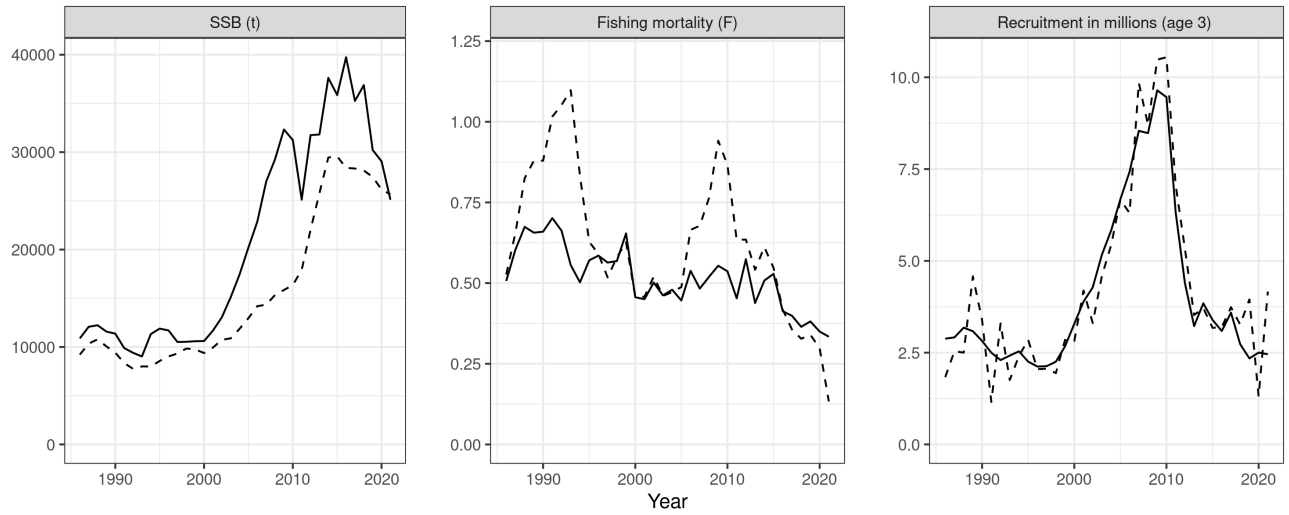

Figure 2 Ling in Division 5.a. Comparison of SSB, fishing mortality, and recruitment (age 3) estimates from the previously used Gadget assessment (dashed) to those produced by the SAM model (black line).

Sources and references

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