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Iceland request to evaluate the harvest control rule for tusk in Subarea 14 and Division 5.a

Advice summary

ICES advises that the proposed harvest control rule for tusk is precautionary and in accordance with the ICES MSY approach.

Request

On 22 December 2016, ICES received the following request from Iceland:
The Government of Iceland is in the process of formally adopting management plans for Icelandic summer spawning herring (5a), ling (5a) and tusk (5a14):The management strategy for Icelandic summer spawning herring, ling and tusk 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.
A part of the management plan is the adoption of harvest control rules (HCR) for the three stocks for setting annual total allowable catch (TAC). The HCR adopted should be precautionary and in accordance with the ICES MSY approach.
The generic form of the HCR is the following:

1. When the spawning stock biomass (SSB) in the assessment year is estimated to be above SSB_{MGT}, the TAC in the following fishing year will be set based on a F_{MGT}.
2. When the SSB in the assessment year is estimated to be below SSB_{MGT}, the TAC in the following fishing year will be based on F_{MGT} (SSB_y/SSB_{MGT}).*
The value of SSB_{MGT} should be defined in such a way that the estimated SSB in the assessment year when fishing at F_{MGT} has a low probability of being below SSB_{MGT} (<5%). The HCR could also be based on proportion of reference biomass in the assessment year instead of fishing mortality in the advisory year.
The work will be carried out by national experts at the Marine and Freshwater Research Institute with input from managers and stakeholders. During this process the HCR will be formed and the stock specific values of F_{MGT} and SSB_{MGT} will be defined. The HCR, along with technical documentation will be submitted to ICES for review by 20th of March 2017.
The Government of Iceland requests ICES to evaluate whether these 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. For ling and tusk the evaluation should also include review of input data and the applied assessment methodology (Benchmark). It is expected that the ICES advice for 2017/2018 fishing year for Icelandic summer spawning herring (5a), ling (5a) and tusk (5a14) be based on the above mentioned HCR.

In further correspondence received by ICES on 19 April 2017, ICES was specifically requested to review the following harvest control rule for tusk:

The spawning stock biomass trigger (MGT $B_{trigger}$) is defined as 6.24 kt, the reference biomass is defined as the biomass of tusk 40+ cm and the target harvest rate (HR_{MGT}) is set to 0.13. In the assessment year (Y) the TAC for the next fishing year (September 1 of year Y to August 31 of year Y+1) is calculated as follows:

When SSB_Y is equal or above MGT $B_{trigger}$:
$TAC_{Y/y+1} = HR_{MGT} * B_{Ref,y}$
When SSB_Y is below MGT $B_{trigger}$:
$TAC_{Y/y+1} = HR_{MGT} * (SSB_y/MGT\ B_{trigger}) * B_{ref,y}$
The current advice deals with the request for tusk. The ICES advice on the requests for ling and herring is available in sections sr.2017.09 (ling) and sr.2017.11 (herring).

Elaboration on the advice

Benchmark assessment and evaluation of reference points
ICES conducted a benchmark assessment and calculated biological reference points. This resulted in B_{pa} = 6.24 kt, based on B_{loss}, the lowest observed biomass (SSB in 2001 as estimated in the benchmark assessment), and $B_{lim} = B_{pa}/1.4$ = 4.46 kt. B_{loss} was chosen as B_{pa} as there was no indication of impaired recruitment at that level. The proposed harvest control rule (HCR) is

not based on F but on a harvest rate (HR) relative to stock biomass of tusk longer than 40 cm (40+ cm). The fishing pressure reference points were estimated for harvest rate rather than for fishing mortality, resulting in HR_{lim} = 0.27 and HR_{pa} = 0.20. MSY reference points were also calculated and resulted in HR_{MSY} = 0.17 and MSY $B_{trigger}$ = 6.24 kt.

Evaluation of candidate harvest control rule

The proposed HCR for the Icelandic tusk fishery sets a TAC for the fishing year September to August of the following year y/y+1, based on a harvest rate of 0.13 on the 40+ cm biomass in the assessment year y ($B_{ref,y}$), modified by the ratio SSB_y/MGT $B_{trigger}$ when SSB_y < MGT $B_{trigger}$. The proposed HCR is considered to be precautionary as it results in less than 5% probability of SSB < B_{lim} in all years (short, medium, and long term). In the long term, and under equilibrium conditions, a harvest rate of 0.17 maximizes average yield (Figure 1). However, as the equilibrium catch curve is quite flat for a broad range of harvest rates, the difference in equilibrium yield between HR = 0.13 and HR = 0.17 is only around 4%. The proposed HCR is considered to be in conformity with the ICES MSY approach.

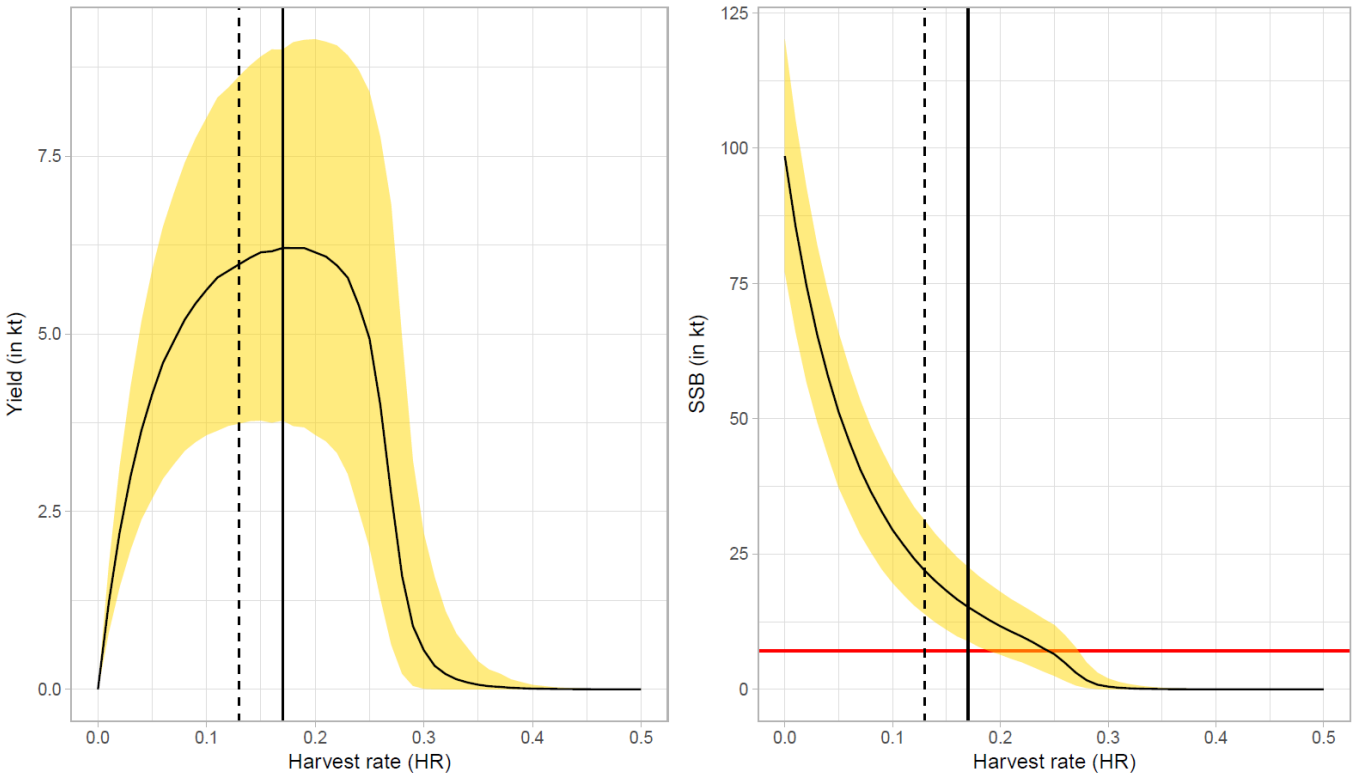


Figure 1 Tusk in Division 5.a and Subarea 14. Equilibrium catch curve (left panel) and corresponding SSB (right panel) as a function of harvest rate (HR). In both panels, the solid black curves indicate the median of the distribution and the yellow ribbons the 5th and 95th percentiles. The vertical lines are HR_{MGT} (0.13) and HR_{MSY} (0.17). The red horizontal line is 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 2016. The objective of the group was to investigate harvest control rules for herring, ling, and tusk that would conform to the precautionary approach and the ICES MSY framework, and to maintain a long-term high sustainable yield.

The proposed HCR is based on a harvest rate approach, using a reference biomass for tusk at 40 cm and above ($B_{ref,y}$). There have been no previous evaluations of this rule.

ICES set up a workshop (ICES, 2017) to evaluate the proposed harvest control rules. For ling and tusk, the work also 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 recruitment, yield, harvest rate, spawning biomass, and the reference biomass of 40+ cm tusk ($B_{ref,y}$) are given in Figure 2. Recruitment, growth and exploitation pattern in the future are assumed to be similar to those observed historically. Under the proposed HCR, future exploitation rates are projected to be lower than those in the past; it is expected this will lead to a higher SSB than those estimated historically.

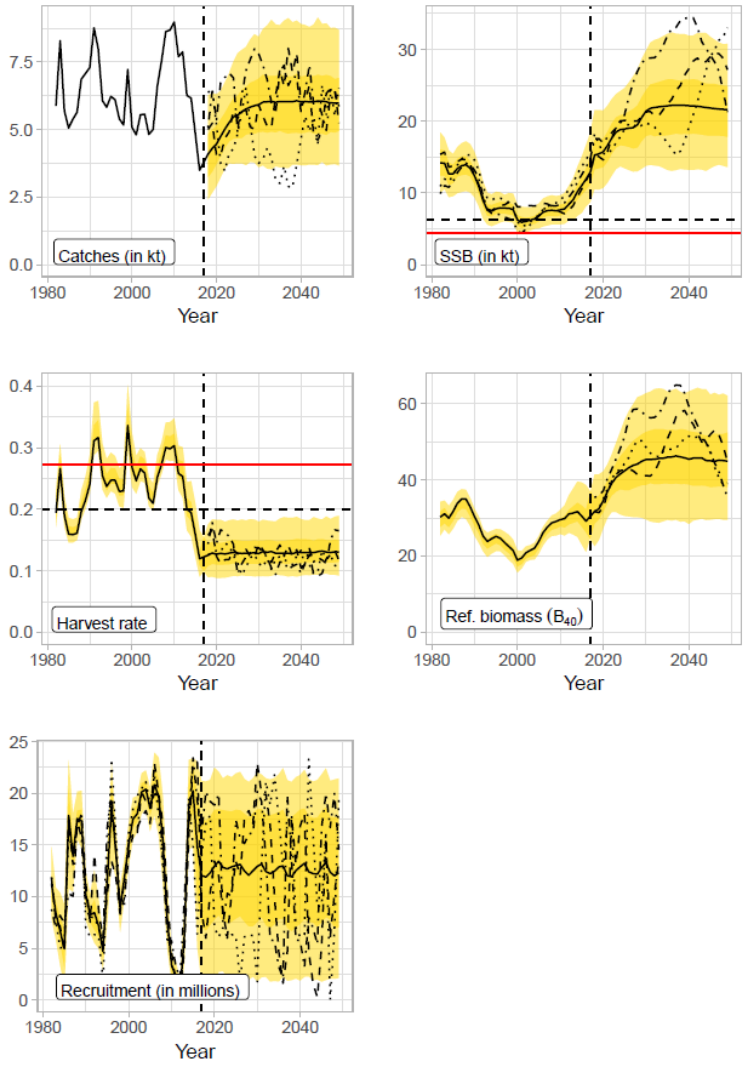


Figure 2 Tusk in Division 5.a and Subarea 14. Simulation results for HR_{MGT} (0.13): Projected catches, spawning-stock biomass, harvest rate relative to $B_{ref,y}$, reference biomass (40+ cm), and recruitment. The black solid lines are medians and the yellow bands indicate the 5th to the 95th percentiles. Red and black dashed horizontal lines represent the limit and PA reference points, respectively, for SSB and harvest rate.

With an HR = 0.13, annual probabilities of SSB < B_{lim} are less than 5% in all years. Higher HRs would be possible without the probability of SSB < B_{lim} exceeding 5%. The reduction in median catch by fishing at HR_{MGT} = 0.13 relative to fishing at HR_{MSY} = 0.17 is only marginal (4%), as the equilibrium catch curve is quite flat for a broad range of harvest rates. The lower HR results in a considerably larger SSB (see Figure 1). Under normal circumstances the stock should rarely fall below MGT $B_{trigger}$, which is set at B_{pa} (Figure 2).

The distributions of the reference biomass ($B_{ref,y}$), SSB, harvest rates, and catches expected to result from implementation of the proposed HCR are shown in Figure 2 and Table 1. These distributions should be used in the future to check that realised

ranges are consistent with expectations. If future observed values were to go outside the range illustrated, this could indicate that there is a need to re-evaluate the assumptions of the simulations.

Table 1 Tusk in Division 5.a and Subarea 14. Median, 5th and 95th precentiles of the projected reference biomass, SSB, harvest rate, and catches for HR_{MGT} (0.13). Weights are in thousand tonnes.

	$B_{ref,y}$	SSB	Harvest rate (HR)	Catches
Median	45.28	21.89	0.13	5.98
5th percentile	29.27	13.89	0.09	3.73
95th percentile	63.45	31.17	0.18	8.63

In the past the assessment of this stock has not included catch information from the Greenlandic part of Subarea 14. Historically the catches from this area have on average been around 1% of the total catches of tusk, but increased to 10–15% of the total catches in 2015 and 2016. This was re-examined in the benchmark. It was not considered appropriate to include catch from the Greenlandic part of Subarea 14 in the assessment before conducting additional exploration as there are doubts about the catch information and whether the tusk in the area constitute a single population. A sensitivity analysis in the Management Strategy Evaluation (MSE), where the catches from this area were included in the stock assessment, showed a minor upward revision in the estimated stock biomass (1%–4% throughout the years) and a downwards revision of the estimated harvest rate (0%–3% in most years, although with an increase in 2015 and 2016). It is hence expected that conclusions from HCR evaluations are robust to not accounting for these catch data. The treatment of the survey and catch data in ICES Subarea 14 in the annual assessment needs to be explored further.

Methods

In the MSE, the operating model that generates the "true" future populations in the simulations was the same as the one used in the annual stock assessment. Uncertainties in parameters estimated in the historical assessment (exploitation pattern, population numbers, growth, and maturity) were included in the simulations. Recruitment was projected using a time-series block bootstrap (blocks of six consecutive years with a randomly drawn starting year) of the estimated recruitment in the assessment period (1982–2016).

The assessment error of the reference biomass was assigned a *CV* = 0.2, based on the estimated error in the stock assessment. The assessment error was auto-correlated in time to emulate observed sequential periods of over- or under-estimation of stock biomass. The autocorrelation parameter, ρ, was set at 0.8, which is assumed to be the upper limit of potential autocorrelation. A short-term forecast is not 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 at the end of the first quarter of the assessment year y. The spawning-stock biomass at the beginning of the assessment year is used to evaluate the stock status relative to MGT $B_{trigger}$.

Sources and references

ICES. 2017. Report of the Workshop on Evaluation of the Adopted Harvest Control Rules for Icelandic Summer-Spawning Herring, Ling and Tusk (WKICEMSE), 21–25 April 2017, Copenhagen, Denmark. ICES CM 2017/ACOM:45. 49 pp.