

2.3.3.1

ECOREGION **Iceland and East Greenland**
SUBJECT **Icelandic request on evaluation of Icelandic cod management plan**

The Ministry of Fisheries and Agriculture in a letter dated 23 May 2009 requested ICES to evaluate the management plan for Iceland cod cited below:

“Since the mid 1990’s the Government of Iceland has attempted through its management scheme for the Icelandic cod fishery to increase the size of the cod stock towards the size that generates maximum sustainable yield. To that end, progress has been made, reflected in lower fishing mortality and increase in spawning stock biomass from historical low of 120 thousand tons in 1993 to 220 thousand tons at present.

In accordance with this general aim, the Government has adopted a management plan for the Icelandic cod stock for the next five fishing years, starting by the 2009/2010 fishing season. The main objective of the management plan is to ensure that the spawning stock biomass (SSB) will with high probability (>95%) be above the present size of 220 thousand tons by the year 2015. According to a medium-term simulation conducted by the ICES North West Working Group this spring (Draft NWWG Report 2009), this will be achieved by applying the following harvest control rule (HCR) to calculate the total allowable catch (TAC):

TAC_{y+1} == (0.2 B_{4+,y} + TAC_y)/2, where y refers to the assessment year and B₄₊ to biomass of 4 year and older cod.

This HCR formulation is based on recommendation from national committee of experts that re-evaluated the performance of the initial catch rule adopted in 1995. The Marine Research Institute, Reykjavik has used this HCR as a basis for advice the last two years.

The Government of Iceland will determine the TAC for the next five fishing years according to this harvest control (HCR) and informs hereby the General Secretary of this harvest strategy.

The Government of Iceland requests the Council to evaluate this management plan at its earliest convenience.”

ICES interpretation: Since the current estimate of SSB in 2009 of 220 000 tonnes may change in future assessments, ICES interprets the management objective as having a more than 95% probability that the SSB in 2015 exceeds that in 2009.

ICES response

ICES advises that the management plan has a high probability of resulting in an increase in the size of spawning stock from the current estimated level by 2015 and beyond. In addition, the plan is consistent with the precautionary approach (low probability of the stock declining to a level where future productivity of the stock may be impaired) and the medium-term projected fishing mortality is consistent with international commitments to achieve maximum sustainable yield (high long-term average yield, F_{max} = ~0.3).

The rule was tested with two scenarios for future recruitment, one assuming that the current low recruitment continues, the other that recruitment will improve in the near future. The main results of the evaluation are presented in the table below and in Figures 2.3.3.1.1-2.

Probability of SSB in 2015 being above SSB in 2009, for a range of percentages of TAC relative to B₄₊ (biomass of cod 4 years and older)

	18	19	20	21	22	23	24	25
Low recruitment	99	98	96	93	90	84	74	65
Improving recruitment	100	100	99	98	97	95	92	87

Although the harvest control rule meets the management objective, there is little tolerance for deviations from the assumptions. If the effective harvest rate exceeds that derived from the rule, as it has in the past, the management objective may not be reached. Furthermore, if the 2008 year class, which is assumed to be relatively strong, turns out to be only at the recent average, the probability of increasing the SSB by 2015 compared to 2009 will be less than 95%.

The rule has been tested under assumptions about stock biology and assessment performance as outlined below. If these assumptions do not hold in the future, the rule should be revisited.

The exact conditions leading to MSY are not well known, and may depend on external conditions. The expected decrease in fishing mortality should increase stock biomass closer to that producing maximum sustainable yield. The projected management plan catch fraction of ~0.2 on average is similar to common proxies for F_{MSY} .

Background

The Marine Research Institute, Iceland was commissioned to carry out analyses and produce a working document that was the basis for the evaluation (ICES, 2009b). The process was overseen by three external reviewers, who acted as a 'shadow group' in the preparatory process and also reviewed the final document. Details of simulations were discussed and agreed in communications between the review group and MRI during the process.

The simulations were made with the program which is also used for routine assessments of the stock. It has an operating model where the stock is projected forwards in time from initial numbers taken from the historical assessment. Catches derived according to the management plan were removed from the stock. The management plan was applied to a value for B4+ (biomass of cod 4 years and older) derived with assessment error from the projected stock. The assessment error was drawn from an assumed distribution, without including annual assessments as part of the simulation loop. The projections were repeated a large number (2000) of times with the stochastic elements listed below. The parameters in the distributions of these elements were selected to reflect the mean of the most recent past.

- Recruitment, either assuming evenly distributed variation within the recent range (70–180 millions) or according to a Ricker function with mean age of the spawning stock as a covariate, assuming a lognormal error with CV = 0.4 and no autocorrelation.
- Weights at age: Log-normally distributed with CV = 0.12) with mean derived from the period 2006–2008, and with autocorrelation 0.6. Since the weights at age in recent years have been lower than those previously observed, applying these values into the future, may be a conservative assumption and implies that the weights at age will be below the historical low in about 50% of the cases.
- Assessment error: Lognormally distributed (CV = 0.15, with autocorrelation 0.45) with a bias of 10%, derived from the discrepancies between the present perception of historical B4+ (for the period 1990–2005) and the perceived B4+ in the assessment performed in each of those years.
- Initial numbers: Consistent with those estimated by NWWG in 2009 (ICES, 2009a), with deviations according to the variance-covariance estimates from that assessment. As in previous harvest rule evaluations, these stochastic terms were inflated to give a CV of the initial B4+ in line with that of the assessment error.

Natural mortality (0.2), maturation at age (average over 2006–2008) and selection at age (representative of the period 1994–2008) in the fishery were assumed constant without error.

Discussion

These analyses are based on a commonly adopted approach that does not fully evaluate all aspects of structural uncertainty (how the real world differs from what is assumed in the assessment model) and thus, the assessment error and amount of bias applied in the current analysis are likely underestimates. To have more confidence in the robustness of the harvest control rule, a full management strategy evaluation would have to be conducted in which the assessment is simulated in more detail. A full management strategy evaluation will also facilitate the examination of suspected sources of structural uncertainty.

In the analyses considered, the tails of the distributions are generally not well-defined (i.e. very sensitive to assumptions) and therefore consideration might be given to using a lower reference level such as 90% probability.

Implementation error (i.e., the difference between the TAC generated by the harvest control rule and the quantity of fish that die due to fishing) can arise from a number of sources, including deviations from the rule and removals in excess of the TAC. The present analyses assume that the removals from the stock equal the TAC corresponding to the rule. The tolerance for implementation error is small without jeopardizing the success of the management plan.

The overall objective of the management of the stock given by the Icelandic Government is to increase the size of the stock so that it generates maximum sustainable yield. While ICES' evaluation of the harvest control rule has a high

probability of producing a biomass increase, it will take a few years to be confident that biomass has actually increased to the extent indicated in the simulations. In this respect, the information gained from applying the present management rule for some years will be informative.

Biological reference points have not been defined for this stock. The latest ICES' assessment and advice, indicates that the SSB in 1993 was the lowest in the time series. This gives an estimated B_{loss} at ~123 kt. The estimated SSB for 2009 is ~220 kt (~1.8 x B_{loss}) which is the reference biomass for the management plan. ICES' evaluation of the management plan indicates a projected SSB in 2015 that has a high probability (> 95%) of being above the estimated SSB for 2009. This statement implies a low probability (< 5%) that the projected SSB for 2015 will be below B_{loss} (a candidate value of B_{lim}) and hence, ICES' evaluates the management plan to be precautionary.

Source of information

ICES (2009a). Report of the North Western Working Group (NWWG), 29 April – 5 May 2009, ICES Headquarters, Copenhagen. ICES CM 2009\ACOM:04.

ICES (2009b) Report of the Ad hoc Group on Icelandic Cod HCR Evaluation (AGICOD), 24-26 November 2009 ICES, Copenhagen, Denmark. ICES CM 2009\ACOM:56. 89 pp.

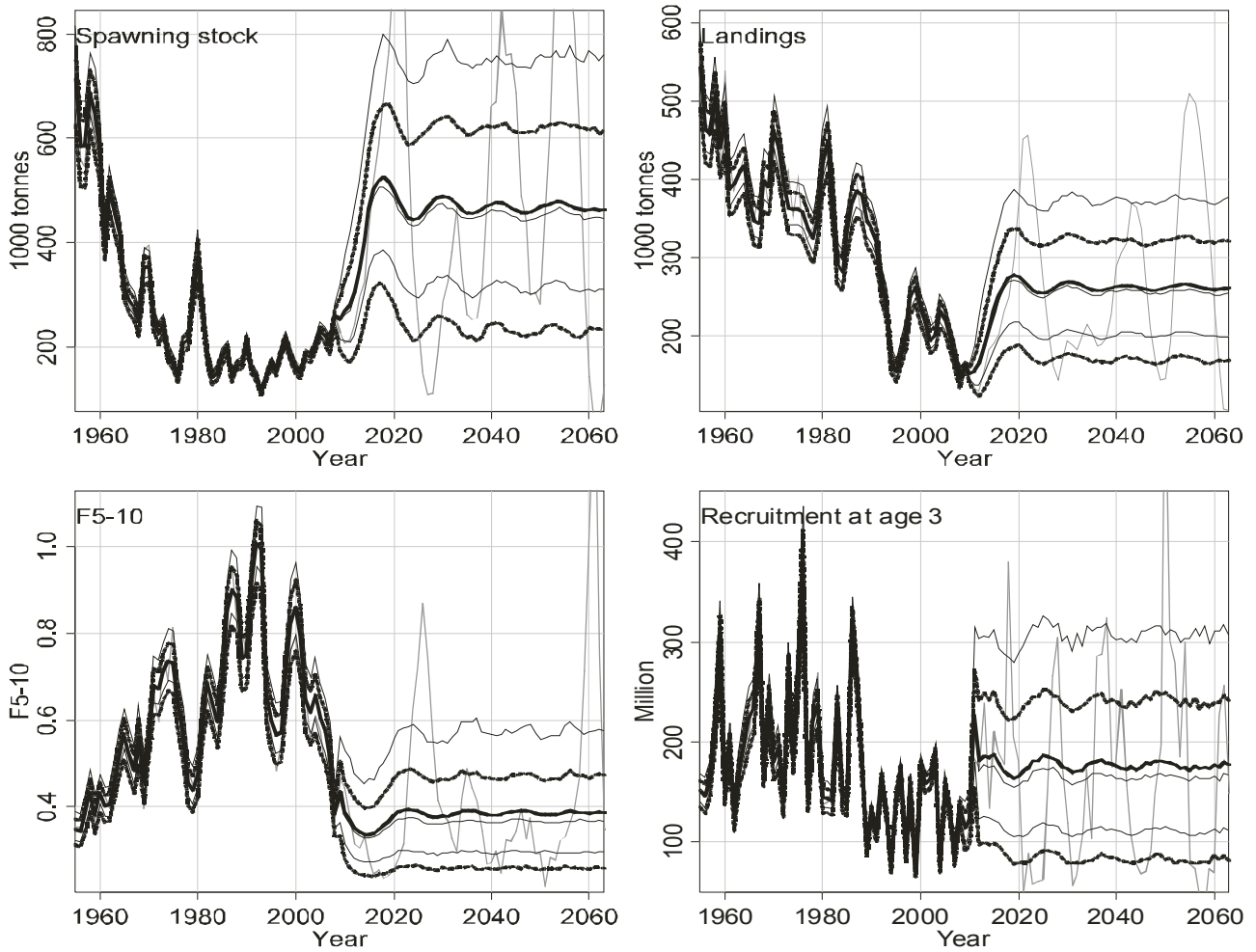


Figure 2.3.3.1.1 Spawning stock, landings, average fishing mortality of age 5-10 and recruitment assuming a recruitment that improves rapidly in the coming years. The figure shows the mean, the median value (thick line) ± 1 standard deviation and the 5th and 95th percentile. The results before 2009 are from the assessments, the results after 2009 are predicted applying the harvest rule with a $TAC/B_{4+} = 0.2$.

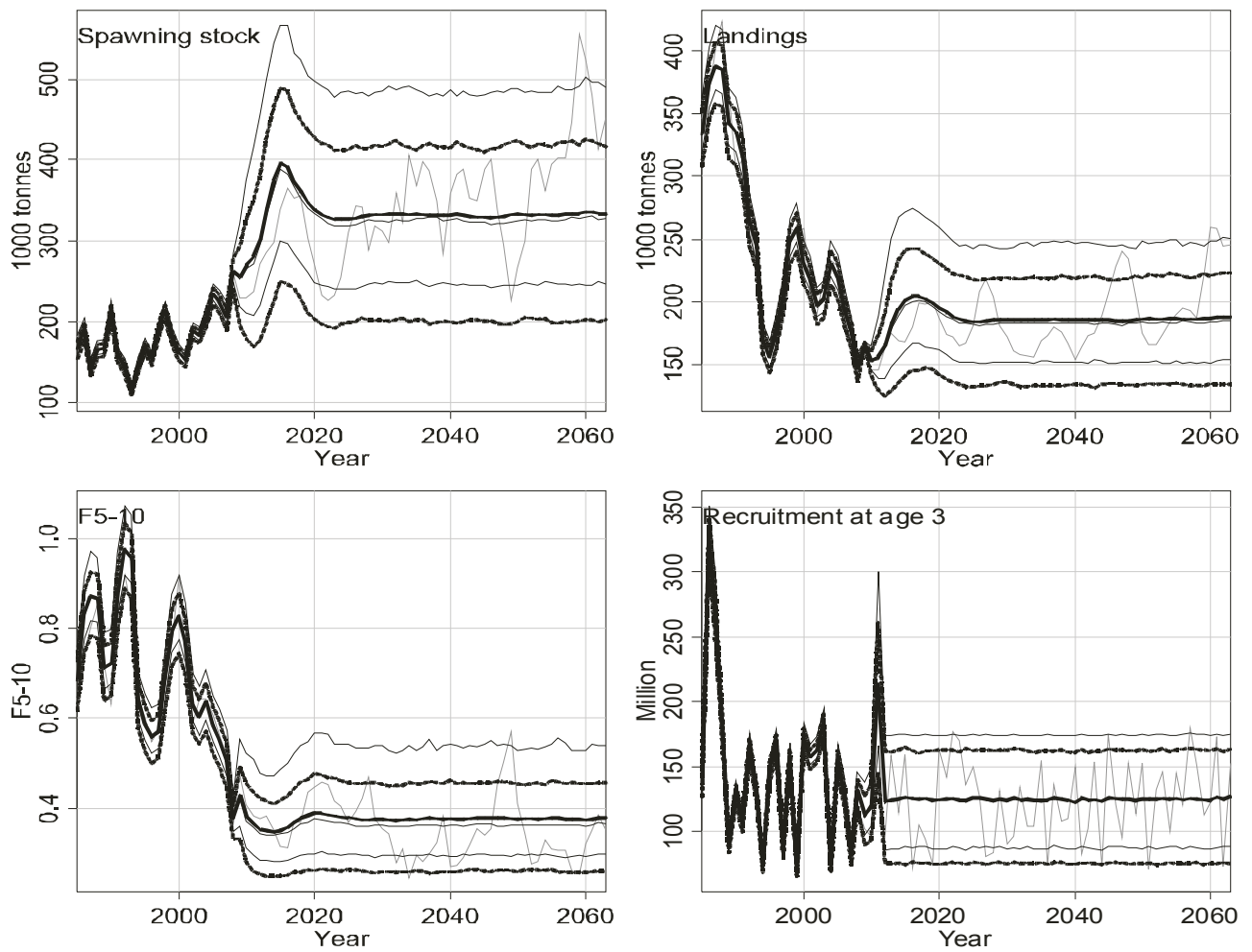


Figure 2.3.3.1.2 Spawning stock, landings, F(5-10) and recruitment assuming a recruitment at the low level in 1985–2007. The figure shows the mean, the median value (thick line) ± 1 standard deviation and the 5th and 95th percentile. The results before 2009 are from the assessments, the results after 2009 are predicted applying the harvest rule with a $TAC/B_{4+} = 0.2$