ECOREGION Baltic Sea
SUBJECT Review of HELCOM draft Red List assessment of cod (*Gadus morhua*)

Advice summary

The advice below relates to each of the questions within the HELCOM request.

Has the HELCOM Red List assessment been carried out appropriately following the criteria of IUCN?

ICES advises that Criterion E should be used to assess reduction in population size, rather than screening assessments using Criterion A for the three cod stocks in the Baltic. In the current HELCOM assessment, ICES advises that Subcriterion A1 should have been used rather than Subcriterion A2 except for the Kattegat stock, and that habitat loss should have been assessed using Criterion B rather than Criterion A, because spawning-stock biomass (SSB) trends were available.

ICES advises that due to the separate past (and future) trajectories of the three stocks, it is not appropriate to assign one IUCN category collectively for all cod in the Baltic.

Has the assessment utilized correctly all appropriate data on the development of the cod stock(s) and its habitats?

ICES advises that further data should have been used in the assessment. With regards to habitats, the best information was generally used, but interpreted in an inconsistent manner, and should have been assessed using Criterion B.

Has the generation time of cod been estimated properly?

ICES advises that the calculation of generation time of cod was consistent with IUCN guidelines, but some of the parameters used were inappropriately specified..

Does any significant immigration exists between the Baltic Sea stock(s) and the North Sea population?

There is insufficient information to advise on the degree of mixing between the cod stocks in the Baltic and in the North Sea. From an assessment and management perspective, separation is assumed between the stocks.

Request

*"ICES is requested to evaluate whether the draft Red List assessment of Baltic Sea cod (*Gadus morhua*) by the Fish Experts Team of the HELCOM Red List project has been carried out appropriately following the assessment criteria of IUCN. More specifically, ICES is asked to check if the assessment utilizes correctly all appropriate data on the development of the cod stock(s) and its habitats. ICES is also requested to review whether the generation time of cod has been estimated properly, taking into account that it should represent pre-disturbance generation length and an age where 50% of the individual reproductive output has been reached. Additionally, ICES is requested to evaluate whether any significant immigration exists between the Baltic Sea stock(s) and the North Sea population."*

ICES advice

Has the HELCOM Red List assessment been carried out appropriately following the criteria of IUCN?

ICES advises that the Criterion E (see IUCN (2012) for descriptions of the criteria) approach should be used, rather than assessment using Criterion A, for each of the three cod stocks in the Baltic (Kattegat, western Baltic, and eastern Baltic). In its application of Subcriterion A2 the HELCOM Red List assessment (the HELCOM assessment) generally follows the IUCN approach as provided in the 2012 guidelines (IUCN, 2012). However, the IUCN screening approaches that comprise Criteria A to D are suitable in relatively data-limited circumstances, but should be replaced if sufficient information is available to take quantitative approaches. ICES advises that quantitative stock assessments, with projections, are the most appropriate tools to determine extinction risk due to reductions in population size. Current fishery assessments, including information on the dynamics of recruitment and their demographic structure, are available for these cod stocks. It is thus possible to apply Criterion E. A further advantage to the fishery assessment process is that the extent to which the current status and trend of each stock is attributable to fishing pressure can be inferred, enabling a better specification of any conservation actions that may be needed.

In the current HELCOM assessment, Subcriterion A2 was used rather than Subcriterion A1. For at least two of the stocks (western Baltic and eastern Baltic) of cod in the HELCOM area, stock sizes are increasing. The causes of earlier decreases are understood and these changes are reversible, i.e. Subcriterion A1 should be used. In the Kattegat, Subcriterion A2 may be more appropriate. Habitat loss should have been assessed using Criterion B rather than Criterion A; as Criterion A uses a proxy for population size when assessing habitat loss and such proxies are not needed because population estimates (SSB trends) are available.

The projections provided in the ICES fishery assessments were not used in the analysis, neither was additional information offered by the stock assessments and the spatial survey data. The ICES projections to provide catch advice were short term, but the methodology could be extended to address the Criterion E probability of extinction.

The three cod stocks in the HELCOM area have separate and distinct past (and likely future) trajectories. It is therefore not appropriate to assign one IUCN category collectively for all cod in the Baltic as this carries the risk of losing important signals from the individual stocks.

Has the assessment utilized correctly all appropriate data on the development of the cod stock(s) and its habitats?

ICES advises that the assessment has not fully used all appropriate data. The HELCOM assessment uses one metric provided by the stock assessments, the SSB time-series (time-series of the biomass of mature fish). However, the HELCOM assessment does not incorporate the additional information provided by the stock assessments, such as population assessments, nor does it consider recruitment dynamics.

The HELCOM assessment considered that habitat loss was a factor in the Kattegat cod stock. ICES advises that this conclusion is not appropriate as the reproductive capacity of this cod stock is reduced (ICES, 2012) and the reduction in habitat use is more likely due to a reduced stock size than to habitat loss (Svedäng *et al*., 2010).

That the 'cod boom years' were removed from the SSB time-series is understandable as the productivity of cod in the Baltic Sea in these years was higher than in the present times. However, much of the argument concerning the change in area of occurrence (spawning habitat) includes the estimates of the area of occurrence from this period of 'cod boom'. This is inconsistent.

Has the generation time of cod been estimated properly?

The IUCN guidelines (IUCN, 2011) provide several ways of calculating generation time. It is not clear in the HELCOM assessment text how the generation time of cod was estimated or whether it followed the IUCN guidelines. Questioned by ICES a member of the HELCOM Assessment group (M. Svensson, pers. comm.) explained how generation time was estimated and confirmed that the process had followed the IUCN guidelines. The IUCN guidance is generic, though, and perhaps not tuned to data-rich circumstances. In this case the life characteristics of Norwegian or global stocks has been used, which may not be appropriate (see Brander, 1995, 2007). ICES recommends that the calculation of generation time should, where possible, be based on the life characteristics of the stock under assessment. ICES does not use "pre-disturbance" generation times in its stock assessments as a harvested stock cannot be regarded as undisturbed (and would be unlikely to return rapidly to a "pre-disturbance state"). ICES calculates current generation times at 2–5 years.

Does any significant immigration exist between the Baltic Sea stock(s) and the North Sea population?

There is no conclusive study on the degree of mixing between cod in the Baltic Sea and the North Sea and this may well vary over time. ICES currently assesses and advises on the basis of three stocks in the HELCOM area, and they are managed as separate entities.

Additional advice

The three cod stocks show differing dynamics. Under these circumstances, the use of metrics of biomass to merge stock information when attempting a regional assessment of population status is unwise, as the signal from the most-at-risk stock is masked by the stronger signal from the healthier stocks. This has occurred in the assessment – see Figures 1, 6, and 7 in the HELCOM assessment. The assessment of the overall status of cod in the Baltic (Table 3 in the HELCOM assessment) is therefore not appropriate.

Background

Previous approach by ICES to the IUCN red listing of commercially exploited fish species.

In 2009, ACOM was asked by Norway to provide advice on the IUCN listing of marine fish species (ICES, 2009). ICES stated:

"*There are three general methods for evaluating extinction risk: (1) screening methods, such as the IUCN redlisting criteria; (2) simple population viability analysis based on time trends; and (3) age structured population viability analysis. The rate of false positives (prediction of extinction which does not occur) and false negatives (the occurrence of unpredicted extinction) is likely to be the highest for screening methods, lower for simple population viability analysis based on time trends, and lowest for age structure population viability analysis. None of the methods are considered reliable for accurately estimating the probability of extinction, but they may be useful to evaluate the relative probability of extinction between species or between management options."*

Later in the advice ICES stated:

"Screening methods may be useful to prompt a more comprehensive analysis, but should not be used as the basis for a listing decision when more detailed data are available, as is typically the case for exploited marine species. Screening methods also only provide an evaluation of stock status at a point in time. They do not include a projection into the future which is more useful for estimating the probability of extinction. As well, criteria based on the rate or magnitude of population decline may overlook the fact that even well managed exploited fish populations can experience large declines. Furthermore, in some cases even a small additional decline may induce a population to pass a tipping point and lead to an increased chance of extinction.

Population Viability Analysis (PVA) is a method that projects a population forward in time using uncertainty to make statements about the probability of population abundance falling below some predetermined level in a given number of years. PVA is useful to indicate the relative risk of extinction (e.g., between stocks) rather than to estimate the absolute probability. The PVA is a forecast of what would be likely to happen to a stock if current conditions remain unchanged throughout the projection period. This assumption of stationarity implies that the conditions that generated the observed values will continue into the future.

Another approach is the Age Structured Population Viability Analysis. In the standard application of this approach the simple PVA is augmented to account for life stage/age structure allowing density dependence and other forms of non-stationarity to occur in the projections. This approach allows comparison of the relative probability of extinction for alternative management options.

Standard fishery models can also be used to examine the risk of extinction. Stock and recruitment estimates can be compared to the replacement line under the current mortality rate. When total mortality is too high, the replacement line will be to the left of recruitment values associated with low stock size, causing the stock to decline. If depensation is present in the stock-recruitment relationship (or if the stock-recruitment relationship changes over time causing a smaller slope at the origin), too high a mortality rate will cause the stock to eventually go extinct. There is no time period involved in this approach, but continued recruitment below the replacement line [at low stock size] *implies a high probability of extinction."*

ICES views a stock assessment with a projection as an appropriate analysis of the likely extinction risk of a commercially exploited marine organism due to reduction in population size. This is a more effective tool than the IUCN red listing Criterion A.

IUCN criteria and the HELCOM proposal

Most of the HELCOM assessment considers the three cod stocks (and the amalgamated HELCOM cod grouping) in relation to IUCN Criterion A – reduction of population size. The proposal suggests that the other IUCN criteria (B–E) are not appropriate and/or able to be applied to these cod populations. The HELCOM assessment document discusses the appropriateness of Subcriterion A1 or A2, and concludes that Subcriterion A2 is appropriate despite the existing management plans for Baltic cod. The assessment considers the decline criterion in relation to SSB (mature adults; IUCN, 2012) and spawning areas.

"Subcriterion A1 if causes of reduction are clearly reversible, understood and ceased.
Subcriterion A2 if the reduction or its causes may not have ceased, may not be understood or may not be reversible."
IUCN (2012)

ICES does not agree with the HELCOM assessment that "*there has been not enough data to apply criterion E*". The IUCN guidelines suggest the use of a PVA (population viability analysis; IUCN, 2011). The ICES stock assessment and management approaches incorporate the "precautionary approach", thus to some extent accounting for a large amount of the uncertainty associated with the stock assessments (see section 9.5 in IUCN, 2011), and also include clear documentation and evaluation of methods (ICES, 2013).

> *"Quantitative analysis (Criterion E).*
> *A quantitative analysis is defined here as any form of analysis which estimates the extinction probability of a taxon based on known life history, habitat requirements, threats and any specified management options. … Quantitative analyses should make full use of all relevant available data. In a situation in which there is limited information, such data as are available can be used to provide an estimate of extinction risk (for instance, estimating the impact of stochastic events on habitat). In presenting the results of quantitative analyses, the assumptions (which must be appropriate and defensible), the data used and the uncertainty in the data or quantitative model must be documented."*
> IUCN (2012)

ICES considers that the availability of quality assured stock assessments, which in turn provides a basis to perform projections into the future, allows for the quantitative calculation of extinction risk, taking the uncertainty of the data into account, which is the requirement under Criterion E. Once such a calculation becomes possible, the nature of a red list assessment changes. Criteria A–D applications typically involve screening methods, with the intent of "waving a flag" to indicate that a more intensive analysis is required. For that reason, the quantification of these criteria deliberately and defensibly errs on the risk-averse side. For example, a population decline estimate of 50% or 70% (depending on the circumstances) can see the subject of the assesment classified as endangered under Criterion A, when in terms of typical fisheries target levels, a population reduced by this extent below its pristine level would be seen to be close to an optimal level for harvesting and securing MSY. In contrast, an analysis meeting the Criterion E requirements subsumes the various considerations taken into account in a screening approach. The Criterion E approach should be integrative, risk-neutral, and a more soundly based process, leading to more reliable estimates of a population status as well as providing the basis to apply the quantitative criteria regarding extinction risk.

Sources

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Svedäng, H., Stål, J., Sterner, T., and Cardinale, M. 2010. Subpopulation structure in cod (*Gadus morhua*) puts strain on the management toolbox. Reviews in Fisheries Science, 18: 139–150.

Sources provided by HELCOM

Assessment of Cod by HELCOM Red List Fish and Lampreys Expert Group 2012-11-08 (assessment justification version 17 December 2012).

Summary of the IUCN criteria and guidelines and additional HELCOM guidelines for conservation status assessments in the HELCOM Red List project.