2.1.4.3 Evaluation of the Management Plan for Cod stocks in the Baltic Sea with regard to the precautionary approach

IBSFC has requested ICES for:


The plan is copied for easy reference in Annex I.

The main elements in the plan are:

Objective: to maintain the stock above a target level.

Instruments:

1. A spawning stock biomass (SSB) minimum level;
2. A target fishing mortality;
3. A minimum increase in SSB in one year should the stock fall below the target SSB level;
4. A maximum variability in TAC from one year to the next;

The exploitation pattern used for evaluation of the management plan is that estimated by ICES in May 2004. ICES noted that the effects of the technical measures adopted in 2003 cannot yet be evaluated. Also, the plan includes a possibility for additional measures but these are not specified and therefore it cannot be evaluated whether these limits might restrict fishing below what is implied by the TAC. The evaluation is based on the assumption that the actual landings correspond to the TAC. For this assumption to hold the requirement is that the implementation practices of recent years are not continued. The continuous occurrences of non-reported landings in recent years illustrate that a simple TAC measure on its own is not always sufficient to ensure a fishing mortality target. Other management considerations including control and enforcements that make the use of both effort restrictions and TAC in combination may be more effective in ensuring correspondence between landings and TAC.

Below it is analysed whether the management plan will lead to the stated objective and whether these stock levels are as implied by a precautionary approach to management.

The assessments of both cod stocks have in the past generally been biased with overestimation of stock size and underestimation of fishing mortality. This is partly a result of the non-reported landings. The following evaluation is based on the assumption that in the future the assessment is unbiased and that the TAC corresponds to the landings.

The estimates of stock size, fishing mortality etc. are uncertain and obviously the estimates of uncertainties are even more uncertain. The evaluation is based on estimates of these uncertainties obtained from the assessments.

Any forward projection of this type is based on knowledge of the history of the stock dynamics. Thus, if a stock suddenly in the future shows an unexpected development for instance as a reaction to a disease outbreak, climatic changes etc., then management must be prepared to react to this, preferably in a pre-agreed way. Furthermore, the stock assessments of both of cod stocks are subject to significant variance resulting in estimates of stock and exploitation which may not be confirmed when more data become available. Unless the assessment becomes much more precise such deviations will occur and when realised management must react with compensatory actions.

Present Status

Western Baltic Cod: Based on the most recent estimates of SSB, ICES classifies the stock as being at risk of reduced reproductive capacity. In the absence of defined fishing mortality reference points, the state of the stock cannot be evaluated with regard to these. An analytical assessment demonstrates that the most recent (2003) estimated fishing mortality (1.12) exceeds the IBSFC fishing mortality reference point (1.00).

Eastern Baltic Cod: SSB cannot be estimated precisely, however, all available information indicates that SSB in the most recent years is below $B_{lim}$. Based on the most recent estimates of SSB, ICES classifies the stock as suffering reduced reproductive capacity. Fishing mortality cannot be estimated precisely, however, all available
information indicates that fishing mortality in the most recent years is well above $F_{pa}$. Based on estimates of fishing mortality in recent years, ICES classifies the stock to be at risk of being harvested unsustainably. Recruitment since the late 1980s has been low.

The assessment of the eastern Baltic cod is particular uncertain *inter alias* due to non-reporting of significant amounts of cod. Any evaluation will therefore be subject to the uncertainties inherent in the assessment. It will in particular affect the evaluation of the initial phase, the three first years.

**Deterministic calculations**

The cod recovery plan includes a target SSB level an upper limit on the fishing mortality and a minimum SSB. The Minimum SSB level is the same as defined by ICES as the ICES $B_{lim}$.

A simple deterministic calculation (yield per recruit combined with a constant recruitment) based on the 2004 assessment – that is uncertain due to non-reporting of landings, insufficient discards data, etc. – provides the following results

<table>
<thead>
<tr>
<th>Stock</th>
<th>Recovery Plan</th>
<th>Calculated (deterministic model)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>SSB (tonnes) (target)</td>
<td>SSB (tonnes) (Management minimum level)</td>
</tr>
<tr>
<td>Western Baltic Cod (SD 22-24)</td>
<td>23,000</td>
<td>9,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastern Baltic Cod (SD 25-29+32)</td>
<td>240,000</td>
<td>160,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

With the current low recruitments for both stocks fishing mortality will have to be lower (for the western stock only marginally lower) than the upper limit specified in the Management Plan to keep the stocks above the SSB targets.

If the SSB improvement in especially the Eastern Baltic Cod (Subdivisions 25-29+32) materialise this might improve the recruitment even under similar bad environmental conditions in the Baltic Sea as currently is prevailing. If recruitment improves then both fishing mortality and yield can be increased compared to the values given in Table above.

The upper limits on fishing mortality and SSB targets will under current low recruitment not lead to the stated target, i.e. under these assumptions the SSB and F targets are not consistent.

These calculations also showed that there is a basic instability in the Management Plan. For Eastern Baltic Cod (Subdivisions 25-29+32) both SSB and yield went into a cyclic pattern. SSB increased to 370,000 t in 2012 and decreased to less than 240,000 t in 2017-2022, for thereafter to increase again. Yield peaked with 150,000 t in 2016 and had a minimum in 2022 with 57,000 t, for thereafter to increase.

**Introducing Recruitment variability - the stock recruitment relationship**

It is well known that recruitment success for Baltic cod and in particularly for the eastern Baltic Cod stock depends on environmental conditions as much as the spawning stock biomass. Sufficient biomass and favourable conditions are both necessary requirements. Recent studies have provided insight in the environmental processes and in the species interactions. A full stock-recruitment model would therefore include specification of the predators on cod eggs, larvae and juvenile cod (including cannibalism) as well as the environmental conditions (e.g. temperature and salinity that defines the so-called “spawning volume”.

2
The environmental conditions would in the short term need to be considered as contributing to the noise in the relationship. It would be possible to establish a species interaction model however, in the short term (up to 3 years) it is not expected that the stock situation would change dramatically.

**Western Baltic Cod**

Recruitment for the western Baltic cod is without trend since 1984 (year class 1983) and the simulations are based on the time series for the period 1984-2003.

![Western Baltic Cod - Recruitment and SSB](image)

**Eastern Baltic Cod**

Recruitment of Eastern Baltic Cod has been rather constant since 1989 (year class 1987) and the time series for the period 1989-2003 is used for simulation of the recruitment.

![Eastern Baltic Cod - Recruitment and SSB](image)
The stock-recruitment relationship that are adopted for this evaluation are a form of worse case scenarios; in reducing the fishing mortality there are two mechanisms that are expected to increase the stock size 1) better usage of the growth potential of the stock, i.e. that fish are allowed to grow to a larger size before they are fished and 2) increased recruitment based on an increase in the spawning stock biomass. For the western Baltic cod the present spawning stock size is above the minimum levels and there is not expected any major increase in recruitment. For the eastern Baltic cod the spawning stock is below \( B_{\text{lim}} \) and therefore an increase in average recruitment is expected. However, recruitment and in particular that for eastern Baltic cod depends on the environmental conditions. It may therefore be considered that the expected recruitment increase will not be realised and the recruitment is restricted by the environmental conditions. The evaluation of the management plan is made using a stock-recruitment relationship that actually assumed that there is little increase in the recruitment in the short term from an increase in spawning stock biomass.

**Would the management plan maintain the stock above Management Minimum Level with high probability and on average lead to a SSB above management target?**

Simulations were set up to include:

- A stock recruitment relationship including recruitment variability (Beverton and Holt relationship and lognormal variability)
- Assessment uncertainty implying that the TAC would lead to a fishing mortality different from the one intended

The uncertainties were set at a CV of 20% for estimating \( F_{\text{at-age}} \), \( S_{\text{at-age}} \) and mean weight-at-age. Natural mortality and maturity ogive were nominally set at a CV of 10%. The recruitment variability was estimated to be 55% for the western stock and 25% for eastern stock.

The low precision of the assessments of the eastern stock may create problems in relation to measuring the actual state and will make it difficult to provide forecasts with sufficient precision as required by the management plan. It may therefore be necessary to implement the management plan based on relative measures and in a more adaptive mode in periods when measurement and prediction precision is low.
Results

1. The management plan is after an initial recovery phase (2-5 years) expected to bring the stocks above the management SSB targets and to bring SSB above $B_{\text{lim}}$ with more than 95% probability. This means that the additional restrictions imposed through the SSB targets are sufficient to introduce the intended increase in the stock;

![Graph of SSB for Cod in Subdivisions 22-24]

- **SSB for Cod in Subdivisions 22-24**
  - Year: 2003 to 2017
  - SSB: 0 to 60,000 tons
  - Graph showing SSB targets and $B_{\text{lim}}$ for 5%, 10%, 25%, 50%, 75%, 90%, 95% confidence levels.

2. The SSB in western stock should within 2 years be above 23,000 tons;

3. Recovery of the Eastern Baltic Cod stock will take about 3-5 years during which time the stock with more than 50% probability will remain below 240,000 tonnes;

![Graph of SSB for Cod in Subdivisions 25-29+32]

- **SSB for Cod in Subdivisions 25-29+32**
  - Year: 2003 to 2017
  - SSB: 0 to 400,000 tons
  - Graph showing SSB targets and $B_{\text{lim}}$ for 5%, 10%, 25%, 50%, 75%, 90%, 95% confidence levels.
4. For the first year when the plan will be in effect the management plan indicates a TAC in the range of 20-25,000 tons for the western cod stock and for the eastern Baltic stock a TAC so low that the fishery is virtually closed. The TACs will then grow to an expected TAC about 30,000 t for the western stock and around 90,000 tons for the eastern stock. Recalling earlier comments on the recruitment in relation to spawning stock biomass the eastern cod TAC hopefully will be larger based on an increase in the recruitments; this however can only be judged when these possible increases have been seen;

5. The evaluation indicates that for the eastern Baltic cod on average and under current recruitment levels it is the SSB restrictions that determine the TAC, the fishing mortality implied by the TAC is below the upper level on the fishing mortality in most situations;

6. The management plan appears to be robust to improvements in recruitment. In such situations it will be the upper limit on the fishing mortality that will determine the TAC rather than the SSB restrictions;

7. The management plan has an inherent long-term instability under current recruitment, i.e. in a situation when it is the SSB restriction that effectively determines the TAC then the plan shows long-term oscillations which in some periods bring the stock below the SSB target;
Conclusion

The low precision of the assessments of the eastern stock may create problems in relation to measuring the actual state and will make it difficult to provide forecasts with sufficient precision as required by the management plan.

The objective of the management plan is in accordance with the Precautionary Approach Reference points defined by ICES;

With an average time horizon for bringing the stocks above $B_{pa}$ (as defined by ICES) of less than 5 years ICES considers the management plan as being in accordance with the precautionary approach. ICES notes that this conclusion is subject to management being able to apply the plan with only minimal implementations errors, and that the assessments in the future are unbiased. The occurrence of considerable unreported landings in recent years indicates that present implementation is not effective and additional measures beyond the present management regime are required and will be a condition for the management plan being precautionary.
Annex I

Resolution XX on the Management Plan for the Cod Stocks in the Baltic Sea
(adopted by the Extraordinary Session, June 2003)

IBSFC agrees to implement the following management plan for the two cod stocks, Eastern and Western Stocks, which is consistent with the precautionary approach, ensures sustainable exploitation and provides for stable and high yield. This management plan replaces IBSFC resolutions X and XVII.

1 MANAGEMENT TARGETS

The management targets are to maintain the Spawning Stock Biomass (SSB) at levels greater than 23,000 tonnes for the Western stock and 240,000 tonnes for the Eastern stock.

2 MANAGEMENT AREAS

The Contracting Parties agree to implement two management areas, one for the Western cod stock and one for the Eastern cod stock.

3 SETTING TOTAL ALLOWABLE CATCHES

a) IBSFC shall only adopt TACs that are predicted by ICES to generate an annual fishing mortality rate not exceeding 0.6 for the Eastern stock and 1.0 for the Western stock.

b) Where the SSB is estimated by ICES to be greater than or equal to the target levels defined in chapter 1, the TACs shall not exceed a level which, according to ICES, will result in the SSB being below the target levels at the end of the year of the application of the TACs.

Within the constraints laid down in paragraph 3a, the TACs shall not be set at levels which are more than 15% less or 15% greater than the TACs of the preceding year.

c) Where the SSB is estimated by ICES to be less than the target levels defined in chapter 1 but above 9,000 tonnes for the Western stock and 160,000 tonnes for the Eastern stock, the following rules shall apply:

i) the TAC shall be fixed at a level which, according to ICES, will result in an increase of at least 30% in the SSB or in a SSB greater than the target levels, defined in chapter 1, at the end of the year of the application of the TAC;

ii) where it will not be possible, according to ICES, to achieve the increase in the SSB indicated in paragraph 3a, the TAC shall be set at the lowest possible level.

Within the constraints laid down in paragraph 3a, the TACs shall not be set at levels, which are more than 15% less or 15% greater than the TACs of the preceding year.

d) Where the SSB is estimated by ICES to be less than 9,000 tonnes for the Western stock or 160,000 tonnes for the Eastern stock, the following rules shall apply:

i) the TAC shall be fixed at a level which, according to ICES, will result in the SSB being above these levels at the end of the year of the application of the TAC and will give an increase of at least 30% in the SSB;

ii) where it will not be possible, according to ICES, to increase the SSB to 9,000 tonnes for the Western stock or 160,000 tonnes for the Eastern stock within one year, the TAC shall be set at the lowest possible level.

4 TECHNICAL MEASURES LIMITING FISHING EFFORT AND MORTALITY

a) IBSFC shall provide for consistency between gear selectivity and the minimum landing size for cod, in order to reduce discards and fishing mortality on juvenile cod.

b) The minimum landing size of 38 cm for cod shall be kept under regular review. In accordance with the development in the stocks and the selectivity in the fisheries, the minimum landing size shall be revised no later than 2005 with a view to adopting an increase to apply from 2006.
c) IBSFC shall, for all fisheries targeting cod, from 2003 keep under regular review the development in the fishing activities, including the impact of closed areas and seasons, and gear regulations in terms of control, conservation and sustainable exploitation objectives. On the basis of scientific advice and any review carried out, IBSFC shall adopt, where appropriate, adjustments to the fishery rules.

5 CONTROL AND ENFORCEMENT

The Contracting Parties of IBSFC shall continue their co-operation on control and enforcement with the aim of establishing a comprehensive and efficient Control and Enforcement Scheme, which supports this management plan and ensures compliance with IBSFC recommendations and Fishery Rules.

6 REVIEW OF THE MANAGEMENT PLAN

This management plan shall be reviewed as necessary, on the basis on scientific information and advice, not later than 2006.