

**ECOREGION**      **Barents Sea**  
**SUBJECT**        **Request by the Norwegian ministry of fisheries and coastal affairs:  
 Evaluation of a rebuilding plan for coastal cod**

### Request

#### Rebuilding plan for Norwegian coastal cod

The Norwegian coastal cod north of 62° N is recognized as a stock complex. Genetic studies indicate that some of the spawning components along the coast could be local stocks - more or less isolated from coastal cod in adjacent areas. Subsequently, the coastal cod management faces two major challenges – those being, first, to keep the total stock complex at a productive level and second, to give protection to potentially vulnerable local stock components. Both of these challenges are addressed in this draft rebuilding plan for coastal cod. Moreover, the knowledge regarding local stocks should be more specified, due to the fact that the scientific advice provided has become increasingly more specific on these matters.

The catch at age analysis (xsa) prepared for this stock has been considered uncertain. This is mainly due to the shortage of information from the recreational and tourist fisheries respectively. Similarly, the division of Northeast Arctic cod and coastal cod in the catches in northern areas has also been deemed uncertain. As a result of this uncertainty, the analyses of annual updates of spawning stock and fish mortality has not been particularly useful when seeking to define reference values for a rebuilding plan. Nevertheless, the coastal survey time series from 1995 onwards could be applied to define a sufficient rebuilding target. Similarly, mortality signals from sampling data could be used to monitor changes in fishing mortality.

#### Rebuilding plan

*The overarching aim is to rebuild the stock complex to full reproductive capacity, as well as to give sufficient protection to local stock components. Until a biologically founded rebuilding target is defined, the stock complex will only be regarded as restored when the survey index of spawning stock in two successive years is observed to be above 60 000 tons<sup>1</sup>. Importantly, this rebuilding target will be redefined on the basis of relevant scientific information. Such information could, for instance, include a reliable stock assessment, as well as an estimate of the spawning stock corresponding to full reproductive capacity.*

*Given that the survey index for ssb does not increase, the regulations will aim to reduce  $F^2$  by at least 15 per cent annually compared to the  $F$  estimated for 2009. If, however, the latest survey index of ssb is higher than the preceding one - or if the estimated  $F$  for the latest catch year is less than 0.1 - the regulations will be unchanged.*

*Special regulatory measures for local stock components will be viewed in the context of scientific advice. A system with stricter regulations inside fjords than outside fjords is currently in operation, and this particular system is likely to be continued in the future.*

*The management regime employed is aiming for improved ecosystem monitoring in order to understand and possibly enhance the survival of coastal cod. Potential predators are - among others - cormorants, seals and saithe.*

When the rebuilding target is reached, a thorough management plan is essential. In this regard, the aim will be to keep full reproductive capacity and high long-term yield.

ICES is asked to evaluate whether the above rebuilding plan is consistent with the precautionary approach. If this is not the case, or if the basis for evaluation is unsatisfactory, further advice for modifications or alternative plans is requested.

#### Comments on regulatory measures

At present, there are several regulatory measures employed. Importantly, the commercial catches of coastal cod are currently taken by vessels that have quotas of Northeast Arctic cod, whereby a small quantity has been added to their quota to cover the expected “by-catch” of coastal cod. Second, the core regulation strategy used to reduce catches of coastal cod has been to restrict parts of the fleet to areas and seasons where they are most likely to catch Northeast Arctic cod. Third, since 2004 only vessels less than 15 meters have been allowed to fish within the fjords, as defined by fjord-

<sup>1</sup>The average survey index in the years 1995–1998

<sup>2</sup> Ages 4–7

lines. Moreover, only vessels less than 21 meters have been allowed to fish between the base lines and the fjord lines. Fourth, long-liners fishing with automatic baiting have to fish outside 4 nautical miles (nm), whereas trawlers have to fish outside 12 nm.<sup>3</sup> Similarly, vessels fishing with Danish seine have to fish outside the fjord lines. Fifth, two coastal cod spawning areas have - in the spawning season - been closed for fishing, except for fishing with hand lines. Finally, some restrictions to the recreational fishery have also been introduced.

All the aforementioned regulation measures can potentially be employed to further restrict catches of coastal cod. In addition to these measures, a principle of increased mesh size can be introduced in coastal areas. This will improve the likelihood of survival to age of spawning, and further, the survival of second time spawning.

Due to the complexity of these fisheries and the variable mixing between Northeast Arctic cod and coastal cod, the exact annual effect of gradually increased regulations has proved difficult to predict. The accumulated effects over several years should, however, be expected to be in line with the above rebuilding plan.

### *ICES' response*

As recognised in the request there are uncertainties related to the analytical assessment of the coastal cod stock complex. Therefore more work is needed to obtain reliable reference points like the biomass corresponding to full reproduction potential and the  $F$  corresponding to high long term yield. The available biological data were considered sufficient for coarse simulations of the effects of the proposed rebuilding plan and for evaluating the extent to which the plan is precautionary. The robustness against uncertainty in survey results and uncertainty in the realised effects of regulations has been explored. More detailed description of the simulations is found in Annex 10 in the AFWG report (ICES, 2010).

### *Assumptions*

ICES notes that "reduce  $F$  by at least 15% annually compared to the  $F$  estimated in 2009" can be interpreted in two ways: fixed steps or gradual reductions. The latest (15% relative to the latest reduction) would lead, after some years, to micro steps that are unrealistic compared to the precision of the surveys and the stock assessment. Therefore, ICES used fixed steps to reduce  $F_{2009}$  to the lower limit ( $F=0.1$ ).

With an  $F_{2009}=0.3$ , the total time span to reach the lower  $F$  limit will be 5 or more years.

### *Technical basis:*

Relative mortalities estimated from survey data and from catch data were scaled to the fishing mortalities of the historic part of an XSA. Thereby, fishing mortality for 2009 was estimated as  $F=0.31$  when recreational catches were included.

In the simulations the input population numbers, exploitation pattern and S-R relationship were taken from a VPA which generated a fishing mortality in 2009 of  $F=0.31$ .

ICES notes that the complexity of these fisheries leads to a rather complex relation between the regulation and the effective effort. The implementation of the planned  $F$ -reductions will therefore be rather uncertain, and the simulations have assumed a rather large implementation error ( $CV=0.3$ ). Also, natural mortality may vary from year to year as a consequence of variable predation but ecosystem considerations have not been directly incorporated into the ICES' evaluations.

The  $F$ -reduction is conditional on the survey SSB results. The consequence is that the uncertainty of the survey will affect the  $F$ -reduction rate, at least when the true stock is stable or declining. Therefore, simulations examined different assumed survey uncertainties ( $CV$  from 0 to 0.3).

It is not known how the proposed rebuilding target (average survey index for SSB over the years 1995–1998) compares with reasonable candidates for  $B_{pa}$  or MSY-biomass. The target is high above the recent survey indices and the plan will thus work in the right direction.

### *Conclusion*

**Based on simulations, ICES concludes that the plan, if fully implemented, is expected to lead to significant rebuilding. Nonetheless, accounting for realistic uncertainties in the catches, surveys, and the assessment model, a rather long rebuilding period is required even if fishing mortality is markedly reduced within the next several**

---

<sup>3</sup> 6 nm in some areas

years. Whilst not fully quantifiable, the needed reductions in fishing mortality will require accompanying reductions in the catches.

ICES considers the proposed rule to be provisionally consistent with the Precautionary Approach. The basis of this evaluation is the precautionary approach, and not the the new ICES' MSY framework. However, it is anticipated that ongoing work will provide a basis for revisiting the consistency of the proposed rule with the ICES' MSY framework in the next year or two.

ICES notes that there is no basis at present for deriving absolute estimates of  $F_{msy}$ . However, it is likely that the current  $F$  is above any candidate values of  $F_{msy}$  and the plan therefore represents a step towards MSY.

Increasing the  $F$  step, or aiming for annual  $F$  reductions irrespective of the survey results during the first 3–5 years, will contribute to faster and more certain rebuilding.

If future observations show that recruitment declines stronger than assumed in the current stock-recruit model, the plan may need revisions.

Recreational fisheries have a significant impact on the stock, and further regulations should be implemented to obtain the  $F$ -reductions specified in the plan.

The stock complex is not fully understood and therefore local depletion should be guarded against. Hence, current regulations aimed at protecting local stock components should be maintained.

#### *Other relevant issues raised by the request*

In the simulations and analyses conducted, no direct attempts were made to take account of the stock complexity. Genetic studies indicate that the cod in some fjords could be separate stocks isolated from neighbouring stocks. An assessment of the combined stocks is not likely to detect fluctuations of the smaller components, and thereby the current assessment approach involves some risk to local stocks. The stock complex is still not fully mapped, but the existence of local stocks calls for special attention in protecting genetic diversity. Although genetic differentiation between cod in different embayment and fjords has not been demonstrated, consideration should be given to conservation measures to prevent further depletion or eradication of local groups of coastal cod. Full monitoring and research on small local stocks requires large efforts and may not be realistic. A possible approach could be to obtain information from local fisheries and look for data that could be appropriate indicators for detecting sharp declines in local stocks. The established strategy of more strict regulations inside the fjords than outside should be continued.

A fixed natural mortality of  $M=0.2$  was used both in the assessment and the simulations. Some fjord studies (Pedersen and Pope, 2003a and b; Mortensen 2007; Pedersen *et al.*, 2007; Aas, 2007) indicate that the main predators on young cod are larger cod, cormorants and saithe. However, there are no estimates of annual predation mortality on the stock complex, thus predation mortality was not taken into account in any of the analyses or simulations. Reduced predator stocks may enhance the rebuilding of cod, while an increase of predators may inhibit the process and require more stringent regulations to achieve the rebuilding target.

#### **References**

- Aas, C.A. 2007. Ungseiens (*Pollachius virens*) predasjon på torskeyngel (*Gadus morhua* L.) og annen juvenil fisk [in Norwegian]. Master Thesis, University of Tromsø, June 2007.
- ICES, 2010. Report of the Arctic Fisheries Working Group, 22–28 April 2010. ICES CM 2010/ACOM:05.
- Mortensen, E. 2007. Er det variasjon i diett og lengde ved alder hos torsk (*Gadus morhua* L.) nord for 64°N? [in Norwegian]. Master Thesis, University of Tromsø, June 2007.
- Pedersen, T. and Pope, J.G. 2003a. Sampling and a mortality model of a Norwegian cod (*Gadus morhua* L.) fjord population. *Fish. Res.*, 63: 1–20.
- Pedersen, T. and Pope, J.G. 2003b. How may feeding data be integrated into a model for a Norwegian fjord population of cod (*Gadus morhua* L.). *Sci. Mar.*, 67 (Suppl. 1): 155–169.
- Pedersen, T., Nilsen, M., Berg, E., and Reigstad M. 2007. Trophic model of a lightly exploited cod-dominated ecosystem. In: Nilsen, M: "Trophic interactions and the importance of macrobenthic invertebrate production in two Arctic fjord systems". A dissertation for PhD, University of Tromsø, Autumn 2007.