ICES responses to BSAC questions 4.4 and 4.11

4.4 BSAC: Question of ecosystem considerations in stocks advice of the Baltic (seals, parasites, food competition, prey-predator)

Last year, BSAC asked several questions pertaining to of the inclusion of ecosystem factors in the single stock assessments of cod, sprat and herring. It was unclear how seal predation was taken into account in the advice. ICES was also asked to come back to the BSAC on the sprat predation on cod eggs in the eastern Baltic. Furthermore, ICES ADG member Jan Horbowy's analysis shows that reducing natural mortality is the key driver needed to restore the eastern Baltic cod stock. What recommendations does ICES have for implementing this? How can managers reduce natural mortality of the cod stock?

Reply
Seal predation
Seal predation is explicitly not taken into account in the assessment and advice.

Cod and grey seals do not have the same distribution in the Baltic Sea. While grey seals are widespread throughout the Baltic Sea, cod is primarily found in the southern part of the Baltic Sea. Thus, the grey seal consumption of cod therefore primarily takes place in the southern part of the Baltic Sea. The first prototype of a model for the grey seal's foraging in the Baltic Sea has been developed. The aim was to describe the spatial distribution and intensity of grey seal predation on cod in the Baltic Sea. The model describes the movement and foraging behaviour of seals during stays in the southern and western Baltic Sea, and compares it with data on cod occurrence. The results are still very preliminary and further development of the model would be required, before drawing any conclusions. Also, the seal diet data should be updated.

Predation by seals was considered at the inter-benchmark process of the western Baltic cod (IBPWEB) to be included in the assessment model. It was decided to be too preliminary (ICES 2021).

Sprat predation on cod eggs
Recruitment of the Eastern Baltic cod is influenced by complicated processes, most of which are in some ways related to hydrographic conditions (salinity, oxygen; see Koester et al. 2017 for a review). Predation by sprat and herring on cod eggs is one of the processes considered to impact on cod recruitment in the eastern Baltic Sea. Predation pressure on cod eggs by sprat and herring depends not only on predator population size, but is additionally influenced by abundance of cod eggs, availability of other prey, hydrographic conditions influencing predator-prey overlap etc. (see Neumann et al. 2014, 2017). Due to other factors involved both in cod recruitment success and in predation pressure of cod eggs, reduced sprat abundance will not necessarily increase cod recruitment.

Natural mortality of cod
The poor status of the eastern Baltic cod is largely driven by biological changes in the stock during the last decades. Natural mortality has increased and is estimated to be considerably higher than fishing mortality in recent years (ICES 2022).

The low growth, poor condition, and high natural mortality of cod are related to changes in

the ecosystem that include (ICES 2022):

- *poor oxygen conditions that can affect cod both directly through altering their metabolism and indirectly through a shortage of benthic prey, as well as the survival of offspring.*
- *reduced availability of fish prey in the main distribution area of cod. Sprat and herring have had a more northerly distribution in recent years, and there is less overlap with the distribution of the cod stock. It is, however, unclear whether the small remaining cod stock would be impacted by this shift of distribution.*
- *high levels of parasite infestations; these coincide with an increased abundance of grey seals. It is unknown whether the parasite infection is the cause or an effect of the poor condition of cod.*

These drivers are interrelated, and their cumulative effect on the cod stock is unclear (ICES 2022).

Fisheries management could possibly contribute to improved feeding conditions for adult cod by limiting fisheries for prey species (sprat and herring) in the distribution area of cod. ICES (e.g. ICES 2018) has advised considering spatial fisheries management for these species. However, further scientific guidance on this matter is presently lacking, as the possible improvement in cod situation resulting from such measures has so far not been quantified (Eero et al. 2020).

The future biomass and potential recovery of the eastern Baltic cod are largely dependent on development in stock productivity (growth, natural mortality and recruitment). At present productivity, the stock biomass would remain at a historic low level even in the absence of fishing. Improved growth and reduced natural mortality, corresponding to their past levels, would allow the stock biomass to increase substantially. Thus, the potential for the stock to support sustainable fisheries in future is much dependent on the ecosystem processes affecting stock productivity (Eero et al. 2020).

Overall, the eastern Baltic cod example demonstrates that science is lagging behind to be able to quantify possible benefits to the stock resulting from management interventions influencing the ecosystem conditions. This is due to a high complexity of the ecological processes involved, and combinations of drivers and stock developments that have not been actual, and thus not in focus for research in the past. No quantitative models are presently available that would be capable of addressing processes related to physiological stress, food limitation and parasites, to compare their relative impacts on fish growth, mortality and reproduction, and evaluate associated management measures (Eero et al. 2020).

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4.11 BSAC: Cod spawning at depths of 20-30 meters and 30-40 meters

Passive gear fishermen have an exemption for fishing flatfish up to depths of 20 meters. Some fishers representatives observe an increase in sea temperatures meaning that plaice and flounder are found in deeper water where it is colder. This raises questions on an increased depth of cod spawning. Does ICES have any more recent evidence regarding cod spawning in SD 25 and 26 at depths greater than 20 meters? Are any investigations of the impact of extending this exemption to depths of 30 and/or 40 meters foreseen?

Reply:
From the late 1980s, the mean depth of both adult cod and flounder distributions has decreased, while that of juvenile cod has increased, and that the depth ranges used by cod and flounder have contracted. This has probably taken place due to a combination of hypoxia in deep waters and increase in predation risk in shallow waters. The net effect of these changes is that adult cod, juvenile cod and flounder overlap more, which may increase the intra- and interspecific interactions (Orio et al. 2019). Thus, the evidence suggests that changes in the depth distribution of flatfish (but also cod) have probably taken place by other factors than temperature change.

The halocline where salinity increases from around 7.5 to 12-16 PSU in ICES sub-divisions 25 and 26 is at around 50 m depth, and above this halocline successful egg fertilization is considered highly unlikely for cod, because of far too low salinity (e.g. Nissling et al. 1994). Thus, fertilization will not take place at shallow waters above the halocline.

However, expanding the depth limit for flatfish fisheries using passive gear from 20m to 30-40m (i.e. inclusion of more offshore areas) will likely have other consequences for cod. The area expansion may include feeding grounds for pre- and post-spawning cod (e.g. Midsjø Bank and Slupsk Bank; (Mion et al., 2022, Uzars & Pliksh, 2000). Hence, there is an increased risk for cod by catch, including increased risk for catching of cod during their spawning migrations.

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