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Coalition Clean Baltic
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Joint CCB and FISH considerations regarding ecosystem-based multi-species management in the Baltic Sea

The EU as a whole has an ambition to move towards long term multi-species management, rather than single-species management. As with several efforts in the past, the Baltic Sea region is to move ahead. For these reasons, a Baltic multi-species management plan has been discussed over the past 3 years. After initial wider consideration, it now looks as if it will cover three main stocks: eastern Baltic cod, central Baltic herring and sprat. This makes the prospect a bit more manageable and we think it is a reasonable focus, considering the challenges involved.

We are, however, concerned about the direction that the ongoing discussions of the new multispecies management plan for the Baltic Sea stocks has taken. Rather than basing it firmly on the ecosystem-based approach set out in Article 2.3 of the regulation on the Common Fisheries Policy (EU 1380/2013), including measures that would minimise the impacts of fisheries and maintain the ecological functions of the Baltic Sea ecosystem, there has been too much focus on optimising overall catch volumes.

We support the development of multi-species management based on biological interactions, in accordance with the Articles 9.1 and 9.3(b) in the basic regulation on the CFP (EU 1380/2013), and we consider the development of regional multiannual plans to be one of the most important responsibilities in the regionalisation process of EU fisheries management (Article 18, EU 1380/2013). The latest advice provided by the International Council for the Exploration of the Sea (ICES) now urgently needs to be revised since the status of the eastern Baltic cod stock has changed dramatically.

Considering all of the above, we now urge decision-makers to be patient and not push through a premature proposal for a Baltic multi-species plan.

Due to EU inter-institutional deadlock, the process of creating a multispecies plan for the Baltic Sea has been both lengthy and jerky, since it has also been a political ambition to establish a plan quickly; this seems to have had a negative influence on the scientific quality of the developing work. The plan should be based on more reliable and validated modelling, as well as best available knowledge and data.

Today, there are several parallel ongoing management processes with major implications for the Baltic fisheries which are crucially interlinked: the implementation of the landing obligation, the development of the multispecies plan and – importantly – the fulfilling of the new objectives of the CFP. Progress in one area should feed into the developments of others; for example, better knowledge on catch composition is hopefully going to be derived from the implementation of the landing obligation and this knowledge should be used to improve the multispecies plan.

We want to emphasize the following aspects of multispecies management in the Baltic Sea:

1. ***Any multispecies management plan must be in line with the ecosystem-based approach to fishery management, and not merely set out to maximise the combined catch volume of the stocks covered by the plan.*** *A stronger focus on the state of the eastern Baltic cod population is necessary. It is the species with the longest life-span and as the dominant predatory fish it has a central role for the whole ecosystem.*
2. ***Management should be coherent with EU environmental legislation and regional agreements such as the HELCOM Baltic Sea Action Plan, especially the Marine Strategy Framework Directive (2008/56/EC).*** *This means that other stock-specific reference points, besides Fmsy, should be included, such as SSBmsy and size- and age distributions (ICES, 2014). Furthermore, objectives for the geographical distribution of each stock should be set, in accordance with HELCOM Baltic Sea Action Plan (HELCOM, 2007).*
3. ***The modelling for projections of exploitation rates used in the ICES multispecies advice (ICES, 2012; 2013a) is based on unrealistic assumptions and the proposed levels of fishing mortality (F) are too high.***
4. ***In order to restore and maintain fish populations to "above levels which can produce the maximum sustainable yield" (Art. 2.2), the exploitation rate (Fmsy) should be below Maximum Sustainable Yield, as it is not possible to manage several interlinked stocks at BMSY levels simultaneously. However, it is possible to manage each of them at or above BMSY levels.***
5. ***Earlier ICES work on multispecies considerations for the Baltic Sea should be used to improve modelling****, such as the "ensemble approach" (ICES, 2009), in which nine different models were included.*
6. ***The current population structure of eastern Baltic cod calls for selectivity measures that will protect large cod, in addition to restrictions of Total Allowable Catch (TAC) and Minimum Conservation Reference Size (MCRS). Harvesting options must be realistic and practical and the existing MCRS for eastern cod (38 cm) should be maintained for now.***
7. ***Priority access to fishing opportunities should be given to the best performers.*** *Proper Environmental Impact Assessments (EIA) should be conducted and fishing operators with the least environmental impact should be rewarded with priority access to fishing resources.*
8. ***The multispecies plan must be adaptive and allow adjustments based on improved knowledge****.*

Introduction

One important aspect of the European Common Fisheries Policy (CFP) is to develop multiannual management plans for commercially exploited fish species, including conservation measures to restore and maintain fish stocks above levels capable of producing MSY. Multiannual plans shall ensure that the utilisation of commercial stocks is sustainable in a medium to long term perspective, as well as provide the fishing industry with realistic possibilities to plan their activities and investments.

Implementation of long-term management after the previous reform was slow, and then came to a complete halt once the Lisbon Treaty came into force. Now that the political deadlock has been resolved, work on multiannual plans can resume in earnest. One of the great challenges ahead will be to shift from single stock management to multi-species management, while also applying an ecosystem-based approach.

The Baltic Sea has been recognized as a region suitable for the development of joint management plans for interlinked offshore fish species, based mostly on biological considerations (STECF, 2012), as the offshore fishing community is comprised of only a few species for which the biological links are relatively wellknown (see Fig. 1).

Both biomass and commercial landings of Baltic fish are totally dominated by three species, namely cod (*Gadus morhua*), herring (*Clupea harengus*) and sprat (*Sprattus sprattus*); altogether these species make up more than 80 % of the biomass and more than 90 % of nominal landings (ECOSTAT, 2009). Although these species are currently abundant in the Baltic Sea, stock sizes have historically fluctuated considerably (Österblom *et al.*, 2007).

Due to the low biodiversity of the Baltic ecosystem, the Baltic fisheries cannot be characterised as truly mixed fisheries; they are mostly directed at a single or a few target species. The Baltic fishing fleet has been slimmed down during the last decade in terms of the number of vessels. Trawlers now catch a larger proportion and there has been a shift from demersal trawlers to large pelagic trawlers, mainly targeting sprat. Today, trawlers land more than 80 % of the total catch of Eastern Baltic cod (ICES, 2013b) and Central Baltic herring and Baltic sprat are almost exclusively caught in pelagic trawls (ICES, 2013c; d). Although fixed gears such as gillnets and longlines are not so commonly used in the offshore fishery anymore, they are still of local importance, especially in coastal fisheries (STECF, 2011).

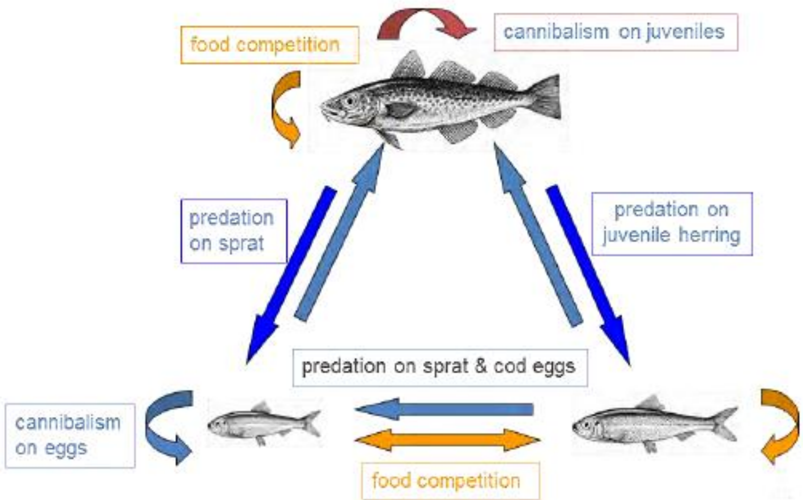

Figure 1. Biological links among cod (top), sprat (below left) and herring (below right). *N.b.* the food competition between sprat and herring and juvenile cod (here noted only as "food competition") is especially competition for zooplankton and crustaceans (i.e. mysids). (Illustration from Rindorf *et al.*, 2013).

The International Council for Exploration of the Sea (ICES) has had joint meetings with the Scientific, Technical and Economic Committee for Fisheries (STECF; which function as an advisory committee for the European Commission in fisheries management) to discuss the development of a management plan for the Baltic Sea in which multi-species considerations are taken.

Aspects to be included in a multispecies plan

Fundamentally, all EU multiannual management plans should be based on the objectives set out in Article 2 of the CFP, specifically 2.2 which refers to stocks at levels above those needed to produce MSY. They should also take as a starting point the ecosystem-based approach enshrined in the CFP objectives.

In future, these plans will also include the provisions for the discard ban plans that are currently being developed, which complement technical regulations such as Minimum Conservation Reference Sizes (MCRS, analogous to minimum landing sizes, 2013/0436 (COD)) and gear specifications (e.g. minimum mesh sizes). Other fisheries management measures, such as periodical (seasonal) or areal fishing closures/restrictions and effort limitations (i.e. number of fishing days) may also be included.

Last year, the Nordic Council of Ministers (NCM) and ICES have jointly produced a background document (Rindorf *et al.*, 2013) on which aspects they recommend should be considered in the multispecies management, see Table 1.

Table 1. Aspects to consider in multispecies assessment and management listed in the Framework for Multispecies Assessment and Management by Nordic Council of Ministers (NCM) and ICES. (Information from Rindorf *et al.*, 2013).

A FRAMEWORK FOR MULTISPECIES ASSESSMENT AND MANAGEMENT BY ICES AND NORDIC COUNCIL OF MINISTERS 2013	
The format of a multispecies plan should include:	• A description of the ecosystem including species interactions. • An identification of the most important interactions which affect management of fisheries. • Advice on the important trade-offs which should be considered in fisheries management.
A multispecies plan should be:	• Precautionary. • Providing yields close to MSY. • In accordance with ecosystem constraints. • Possible to communicate to managers and policymakers.
A multispecies plan should include ecosystem descriptions of:	• The main actors and their interactions, • The main environmental drivers and human pressures affecting the ecosystem • How the interactions have changed over time.
General community indicators used in a multispecies plan could be:	• Natural and total mortality by age. • Percentage of total mortality caused by natural sources. • Proportion of large fish in community. • Biomass by guild (for example forage fish). • Spatial distribution pattern and area occupied. • Condition factor or mean weight at age.

Several of these aspects are sadly neglected or overlooked in the ICES advice on a multispecies plan from 2013, and we would like to highlight eight areas that we consider it important to include in the multispecies plan:

1. ***Any multispecies management plan must be in line with the ecosystem-based approach to fishery management, and not merely set out to maximise the combined catch volume of the stocks covered by the plan.*** *A stronger focus on the state of the eastern Baltic cod population is necessary. It is the species with the longest life-span and as the dominant predatory fish it has a central role for the whole ecosystem.*

Cod is the most numerous species that mainly feed on fish in the Baltic Sea , although the proportion of fish in its diet vary with size, and it has a major influence on the whole Baltic ecosystem (Casini *et al.*, 2012). Recent findings indicate that the eastern cod population is in a bad state. Over the past two years, the spawning stock biomass (SSB) is estimated to have decreased by more than 20 per cent (ICES, 2014) and the stock is currently comprised of a disproportionally large fraction of small and thin individuals (Eero *et al.*, 2012); especially larger individuals seems to be in bad condition (see Fig. 2).

Cod in general is highly limited by hydrological conditions (salinity and oxygen levels in bottom water) and recent reproduction has only been reported from the Bornholm Deep (SD 25) and to lesser extent in SD 26. The abundance of cod in northern areas is nowadays very low, but the reasons for this are not fully understood.

Lack of sprat and herring in regions with high abundances of cod has been considered a major reason for the many thin cods. However, new information indicates that at least seasonally the occurrence of sprat is may be high enough in areas where cod are most abundant (i.e. southern Baltic Sea (SD 25); Stefan Neuenfeldt, National Institute of Aquatic Resources, Technical University of Denmark, pers. comm., 2014).

Additional factors related to the spread of hypoxic bottoms (as a result of eutrophication) may also explain the poor body condition of Eastern Baltic cod. Swedish scientists recently concluded that a combination of hypoxic bottoms and competition for space may control the population (Svedäng & Hornborg 2014). Due to the low oxygen levels, the benthic areas that cod can inhabit and where they can find other prey than clupeids (e.g. benthic invertebrates) have declined. Since eastern cod currently grows more slowly than before, ICES have not been able to make any reliable assessment for catches in 2015 and has classified the stock as data-limited – however, this is not because the stock really is data-limited – on the contrary it is data-rich – but due to the great uncertainties that the assessment working group was facing.

Due to the impending threat of synergistic effects of eutrophication of the Baltic Sea and climate change, both HELCOM and IUCN have also classified cod of the Eastern population as vulnerable (HELCOM, 2013).

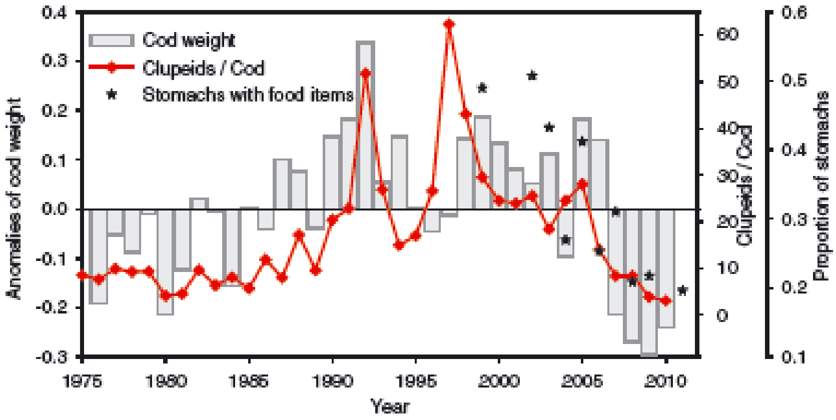

Figure 2. Decrease in mean weight of larger individuals of the Eastern Baltic cod stock (4–7 years) in Subdivision 25, and changes in the ratio between biomasses of clupeids and cod. Stars are denoting proportion of analysed cod with food items in stomach. (Illustration from Eero *et al.*, 2012).

2. ***Management should be coherent with EU environmental legislation and regional agreements such as the HELCOM Baltic Sea Action Plan, especially the Marine Strategy Framework Directive (2008/56/EC).*** *This means that other stock-specific reference points, besides Fmsy, should be included, such as SSBmsy and size- and age distributions (ICES, 2014). Furthermore, objectives for the geographical distribution of each stock should be set, in accordance with HELCOM Baltic Sea Action Plan (HELCOM, 2007).*

Solely aiming for MSY is insufficient in long-term fisheries management and other considerations, such as age distribution in the stocks, are needed (Goodyear, 1996). During the last decades, the condition (length-weight relationship) of sprat and herring have changed considerably, mainly due to increased competition for food but especially since sprat has become more abundant during periods of low cod abundance (Österblom *et al.*, 2007). There are also recently published studies indicating that climate change and smaller body sizes are correlated due to larger individuals being more sensitive to the lower oxygen levels in warmer water (Baudron *et al.*, 2014).

Even if the reasons for changes in size and age distributions are not fully understood, as in the eastern cod example described above, it is evident that it is very important to monitor and consider these parameters in the management. They are also one of the criteria under Descriptor 3.3 (population and size distribution) in the EC guidance paper on Good environmental Status (GES) of marine waters (2010/477/EU) linked to the MSFD, as is the evolutionary effects on fish stocks due to fishing activities, criterion 3.3.4). However, ICES has not yet started to assess Baltic stocks on the basis of age and size distributions, and some Member States argue that there is not enough scientific knowledge and information available to define an age and size distribution which is indicative of a healthy stock. At recent ICES meetings on Descriptor 3 (Copenhagen, March 2014, and the WS in Brussels on 3–4 of April)[1], scientists expressed that fish stocks have to be exploited at MSY for a number of years in order for them to be able to predict what healthy size and age distributions really

[1] https://circabc.europa.eu/sd/a/d875d4e9-64e6-4ee9-9400-7656d275bc1d/Draft%20recommendations%20for%20the%20assessment%20of%20MSFD%20Descriptor%203.pdf

are. Furthermore, the large and periodical environmental variations in the Baltic Sea make this task especially difficult.

Although these arguments should be acknowledged, it is crucial to develop the MSFD criterion on size and age distributions of commercial fish stocks in order to achieve the holistic objectives of the directive, aiming to relate consequences of different human-induced effects (i.e. the different descriptors listed in the MSFD) on the environment. The possible relationships between eutrophication – hypoxic/anoxic bottoms – food deficiency and the stunted growth of the eastern Baltic cod stock, as discussed earlier in this paper, is an example of the need for broader, more ecosystem-based fishery management.

Since it is a legal obligation of EU Member States to implement the MSFD, Baltic Member States should be pushing for its inclusion in the Baltic multispecies plan.

3. ***The modelling for projections of exploitation rates used in the ICES multispecies advice (ICES, 2012; 2013a) is based on unrealistic assumptions and the proposed levels of fishing mortality (F) are too high.***

Since 2012, ICES has produced multispecies advice for the Baltic Sea based on the stochastic multispecies model (SMS)[2] (ICES, 2012; 2013a). Basically, the SMS model [currently] projects that although the yield of cod will be of a similar level if the fishing mortality (F) for cod ranges between 0.4–0.6, the yield of clupeids will significantly increase with increased fishing mortality (F), mainly due to reduced predation pressure. According to the model, the sprat population in particular reacts quickly to lower cod abundances, whereas the size of the herring population is less affected. The effects of increased predation by cod on the herring population seem to some extent to be counteracted by a reduced competition from sprat for the same food resources (see Fig. 3).

In the advice, the fishing mortality (F) is given in ranges since the natural mortality depends on the abundance of interlinked species (in this case cod, sprat and herring). The parameters included when establishing Fmsy is mainly Spawning Stock Biomass (SSB) and food availability.

[2]For more details on the SMS model, see ICES 2012 and ICES 2013a.

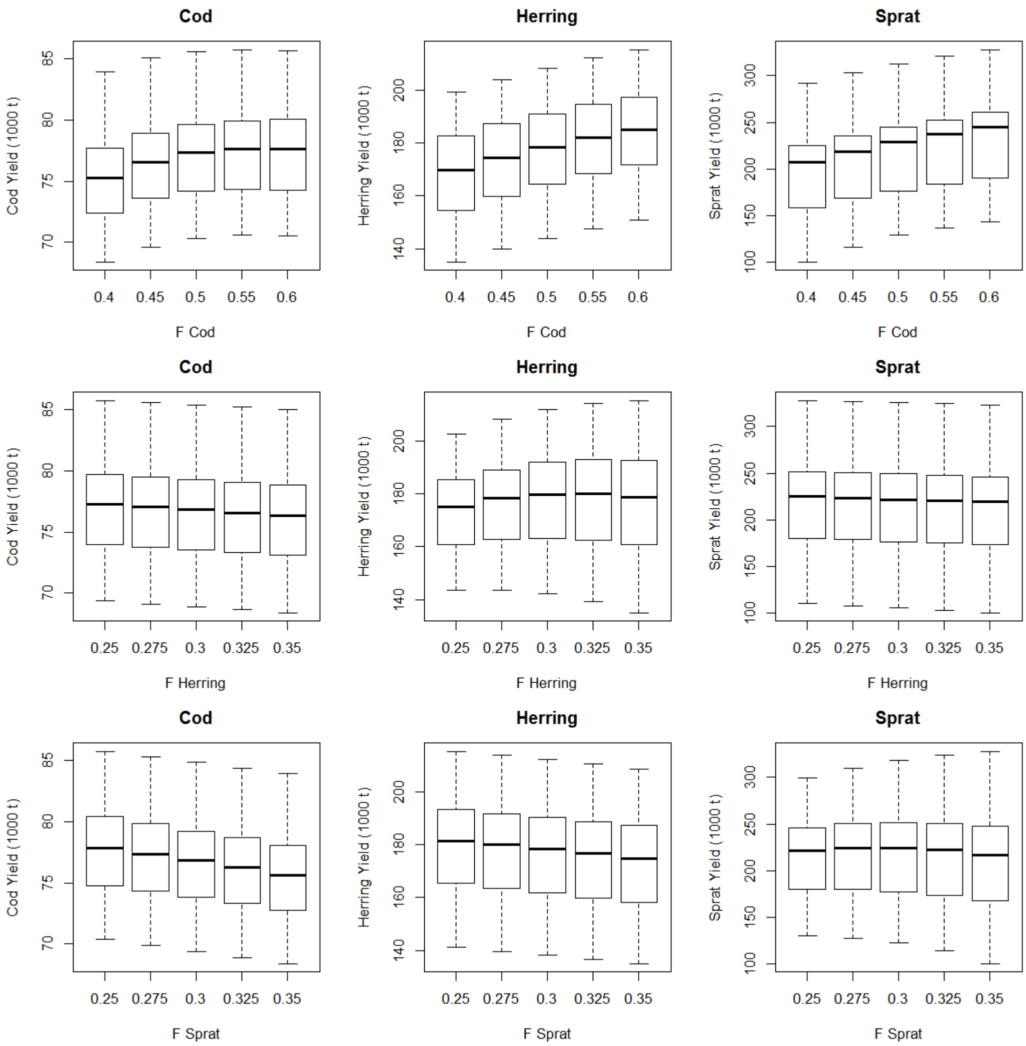

Figure 3. Graphs suggesting how the yield of cod, herring and sprat may depend on F values for the other species in a Baltic multispecies environment, simulated by the stochastic multispecies model (SMS). (Illustration from ICES, 2013).

ICES stresses in its multispecies advice (ICES, 2013a) that the assumption of a geographical overlap of species used in the SMS model is not correct and that it will have implications for the validity of the projections. The more northern distribution of sprat (Fig. 4) implies that the availability of sprat as prey for cod, which mostly occur in the southern part of the sea, is limited and therefore the interspecific effects of different F values are not as clear as suggested in Figure 3.

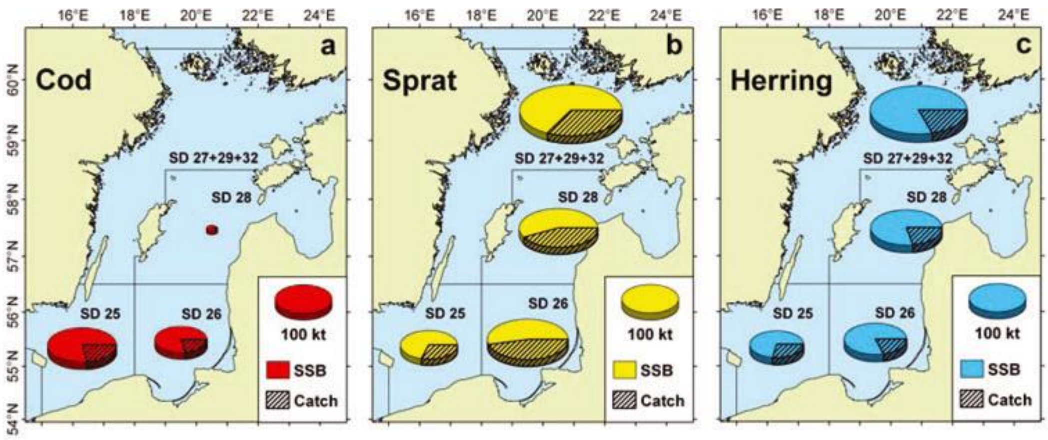

Figure 4. For each Baltic subdivision (SD), the Spawning Stock Biomass (SSB) of cod, sprat and herring for 2010 is given, including the proportion of catch (marked as dashed areas in pie charts). (Modified illustration from Eero *et al.*, 2012)

As illustrated in Figure 5, the high F level (F_{MSY} ~0.55) suggested in the SMS model clearly stands out in comparison with other European cod stocks that ICES provides advice for, as well as two North-American stocks which are included in the figure to further illustrate the strangely high Fmsy value proposed for the eastern Baltic stock. Most notably it is more than twice the level suggested for the western Baltic cod stock (Fmsy = 0.26). Such a large difference in exploitation rates may lead to increased risk of overfishing of the western stock as well. This is backed up by the STECF (2012) conclusion that the current knowledge about the degree of mixing between the western and the eastern Baltic cod stocks is not sufficient to allow increased fishing in bordering areas.

This high F-value advised by ICES for the eastern Baltic cod stock has been criticised, interestingly enough by some of the scientists that provided the background data for the analysis. According to Millar and Cardinale (ICES, 2013e), a more appropriate F-value should be in the region of 0.31. This difference is due to the fact that in the current SMS simulations, only data from 1989 and onwards were used as it is argued that a major trophic shift occurred in the Baltic ecosystem at that time. However, according to Millar and Cardinale, a major change in the specific recruitment capacity for the stock occurred already in the beginning of the 1980s, when important habitat suitable for reproduction disappeared due to the spread of deoxygenated bottoms. Therefore, they have used time series from 1982 in their simulations. Since then, the spawning of Baltic eastern cod has in practice been restricted to one area within the Baltic Sea (the Bornholm Deep). It shall also be noted that, by using similar simulations for the western Baltic cod stock, these scientists have come up with F-values in the same range as for the eastern cod stock (0.26 and 0.31, respectively).

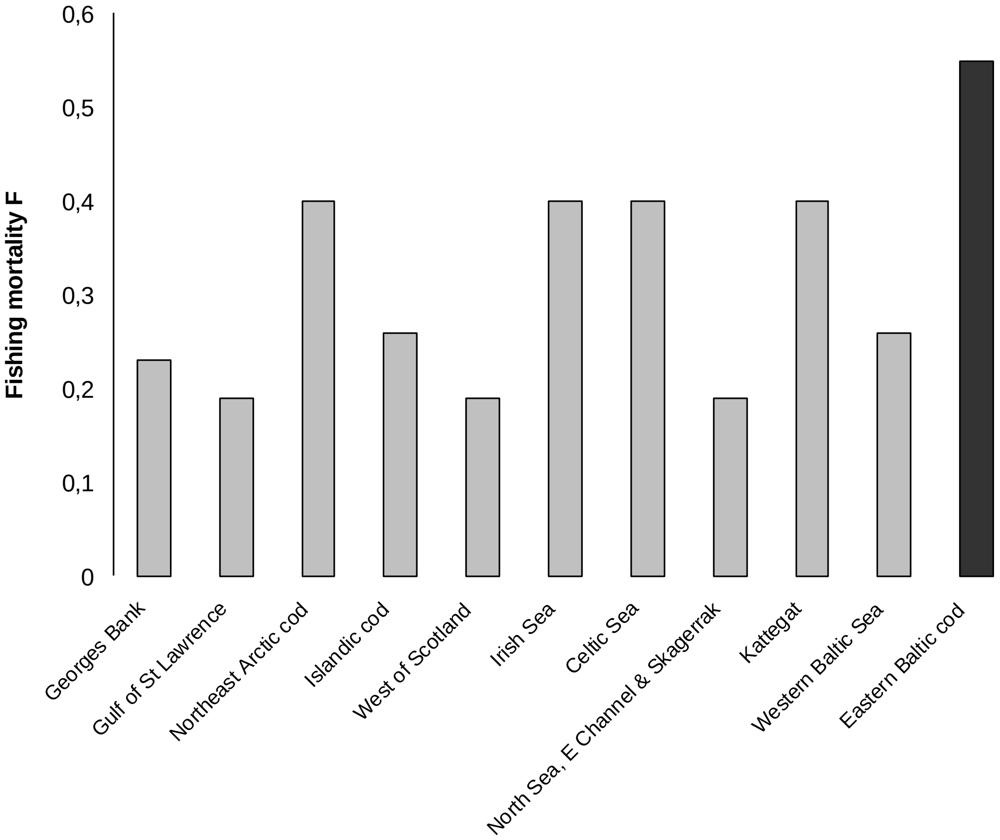

Figure 5. Fishing mortality for European cod stocks for 2014 advised by ICES (2013). For eastern Baltic cod, a range for multi-species advice is given (F~0.55). For other stocks, single species advice is given (single species advice for the eastern Baltic cod is F = 0.46). For additional comparison, Fmsy recommendations provided by the National Oceanic and Atmospheric Administration (O'Brien *et al.*, 2012) for cod stocks in the George Banks and Gulf of St Lawrence (NAFO areas 5Z and 3Pn4RS, Department of Fisheries and Oceans, Canada national management, 2012) are included.

In addition to uncertainties regarding the spatial overlap of species, better data on cod diet are also needed; there are ongoing discussions on how to interpret the diet data: for example, is a high degree of cannibalism correlated with large cod stocks, as assumed in the SMS model? Furthermore, the SMS model mainly considers one-way predator-prey relations and consequently information on how the cod stock is reacting to high numbers of clupeids (besides as prey) is lacking in the model. An important factor related to this which could be included in a model are the cascading effects strong predation on zooplankton by clupeids can have on eutrophication of the Baltic Sea (Casini *et al.*, 2008), which in turn affects the cod stock due to limitation of suitable habitat (see discussion above).

Initially, after launching its first multispecies advice for the Baltic, ICES was clear about the shortcomings of the analysis and stated that that first model should be considered a starting point for the discussions between ICES and managers on how to develop a multi-species management plan for the Baltic Sea. Nevertheless, the levels of fishing mortality (F) that were presented in that initial report have been taken more seriously than the stated intention of just being a starting point. Eventually, even ICES has begun to use its initial multispecies advice despite the shortcomings, for example in the ICES advice for the eastern Baltic cod for 2014, where the multispecies exploitation rate of F~0.55 is suggested for cod (ICES 2013b).

4. ***In order to restore and maintain fish populations to "above levels which can produce the maximum sustainable yield" (Art. 2.2), the exploitation rate (Fmsy) should be below Maximum Sustainable Yield, as it is not possible to manage several interlinked stocks at BMSY levels simultaneously. However, it is possible to manage each of them at or above BMSY levels.***

Currently, EU fisheries are mainly managed on a single-species basis according to the MSY concept, derived from the "surplus production theory" (Francis, 1974). To implement the MSY approach to all stocks simultaneously in multispecies management is challenging (e.g. Maunder, 2002). Since the stocks are interlinked in different ways, fishing pressure on one stock will influence the size development of other stocks (most clearly illustrated in predator-prey relationships). It is, however, possible to manage them at or above SSBmsy levels, in line with international agreements such as the Johannesburg Declaration 2002 and the United Nations Fish Stocks Agreement (UNFSA). This would increase the likelihood that important ecological functions of key species are maintained, e.g. the eastern Baltic cod. Furthermore, fishing at Fmsy levels has been criticised for not taking fluctuations in recruitment into consideration – a highly relevant aspect for the eastern cod population which is dependent on strong inflows of oxygenated Atlantic water into the Baltic Sea for successful reproduction (Köster *et al.*, 2005). Additionally, the dependence of other species on these stocks is rarely accounted for when determining MSY levels, such as the importance of clupeids as prey for seabirds (Cury *et al.*, 2011).

5. ***Earlier ICES work on multispecies considerations for the Baltic Sea should be used to improve modelling,*** *such as the "ensemble approach" (ICES, 2009), in which nine different models were included.*

In 2011, the Commission and Member States decided to replace the Baltic cod plan (EC No 1098/2007) with a multispecies management plan, in which interspecific relations should be included (STECF, 2012). However, already in 2008, the Commission requested ICES to develop joint considerations for multi-annual management of the Baltic Sea so that sustainable harvesting of Baltic stocks could be secured, also in a long-term perspective.

At that time, a total of nine different models were run and the outcomes projected for different climatic and fishing scenarios were compared in a so-called "ensemble approach". The models used were four single-species cod models, four multispecies models and one foodweb model. Although the projections of the models showed the same trends, some of them were also considered not to be fully trustworthy, as they were still in the "developing phase" (ICES, 2009). Not all of the models were operative in the sense that projections of F-values could be derived from them, and this is probably one of the reasons for why focus has shifted from the "ensemble approach" to only the SMS model. Although several models have been compared with the SMS, using the same in-data to validate them (e.g. BALMAR and the MSI-SOM models, see ICES 2009; 2013e), aspects of wider ecosystem considerations, especially environmental/climate change, are lost when using only these operative models in comparison to the "ensemble approach". Another explanation for currently only using the SMS model is surely the strong demand from the Commission on STECF and ICES to deliver multispecies advice within a short timeframe, which ICES also managed to do.

Due to the earlier inter-institutional deadlock between the Parliament and the Council, the development of the multispecies plan stalled. Meanwhile, some of the scientists involved in the earlier ICES work on the ensemble approach have continued their work and recently published their results (e.g. Gårdmark *et al.*, 2013). Some of them are also engaged in the ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea (WGIAB), aiming to provide ecosystem-based fish stock advice and management for the Baltic Sea (Möllmann *et al.*, 2013).

We want to stress that this work should be given further attention and that alternative models which broadens the narrow predator-prey perspective of the SMS model currently used by ICES are needed. Besides stock-specific responses to different climate and fishing scenarios, inter-species aspects besides predation need to be taken into account. For example, the condition of sprat and herring might have considerable effects on the condition of cod, both on individual growth and reproduction. There are also other ecosystem effects due to high/low abundances of clupeids which are related to eutrophication and hypoxic bottoms.

6. ***The current population structure of eastern Baltic cod calls for selectivity measures that will protect large cod, in addition to restrictions of Total Allowable Catch (TAC) and Minimum Conservation Reference Size (MCRS). Harvesting options must be realistic and practical and the existing MCRS for eastern cod (38 cm) should be maintained for now.***

As described earlier, the size distribution of the eastern Baltic cod stock is currently skewed towards smaller individuals. An undisputed fact about cod is that the largest females are the most important for reproduction, since the average roe produced by these individuals is larger and the fry have higher survival rates; also the buoyancy is higher for larger eggs, which is particularly important in the Baltic Sea as the probability of survival is higher for roe floating in the upper and more oxygenated part of the water column (Vallin & Nissling, 2000).

What we can do about this skewed size distribution is disputed. The disadvantages of targeting only fish above a certain size in the commercial fishery have recently been raised by Svedäng & Hornborg (2014). We acknowledge this problem and its potential effects on the size and age distribution. However, instead technical measures could be applied in the fishery which selects only for a specific size range of cod, avoiding both the smallest and the largest individuals. The only fishing gear currently used in the Baltic cod fishery that has such a size selection pattern is gillnets (Madsen, 2007). There are efforts underway to develop grids in the Baltic demersal trawl fishery in order to avoid larger cod, and the initial results are positive (Daniel Steputtis, Institute of Baltic Sea Fisheries, Germany, pers. comm., 2014). Until such measures can be used in practice, however, it is our view that the existing MCRS for eastern Baltic cod (38 cm) should be maintained in combination with a low fishing pressure, especially considering the current state of the eastern cod stock.

Today, the Baltic Member States seem to have reached a broad political agreement to reduce the MCRS to 35 cm. Aside from putting the stock further at risk, such a reduction would be in direct conflict with the European Parliament statement that size at first capture should be scientifically based and reflect the age and size at first reproduction (COM(2011)0425 – C7-0198/2011 – 2011/0195(COD)) in the negotiations on the basic regulation of the CFP. We fear that if the MCRS is lowered, especially in combination with an increase in F in line with the ICES multispecies advice, it would threaten the reproductive state of the stock. In the trade-off between early maturation and growth among juvenile fish, there is a risk that the already indicated fisheries-induced evolutionary selection towards young and small-sized spawning individuals (Vainikka *et al.*, 2009) would be reinforced by the targeting of individuals only 35 cm in length.

There is an ongoing discussion about how to exploit fish stocks more efficiently. In the development of multispecies plans, the underlying rationale is often to exchange natural mortality with fishing mortality. If implemented, this would affect associated non-commercial species as well not included in the plan (as noted earlier, the SMS model does not include more indirect ecosystem considerations) and is the reason behind the higher estimates of Fmsy in multispecies management compared to single-species management.

Another theory about how to exploit fish stocks more efficiently is the concept of "balanced harvesting", which is based on the idea of unselective harvesting targeting individuals in populations in relation to their natural productivity (Jacobsen *et al.*, 2014). This concept is, however, rather theoretical and some of the most influential studies (e.g. Garcia *et al.*, 2012; Kolding & van Zwieten, 2011) are either only based on model predictions or on experiences from African lakes, where the fisheries are very diverse and small fish are marketed and consumed.

Furthermore, the models used for "balanced harvesting" simulations often do not include the whole size structure of the species; they only include a few life stages and assume food-independent growth from one stage to the next. It can therefore be questioned how well these simulations reflect the outcome of balanced harvesting – if it was possible to implement it in practice – especially in a region with very different conditions such as the Baltic Sea. However, a recent modelling exercise of balanced harvesting on mixed fisheries performed by Jacobsen *et al.* (2014) is relevant, since they have included full life history of the individual fish from egg to adult in their simulations. They modelled four different harvesting scenarios based on whether they are selective or not and/or balanced or not (i.e. whether catch compositions reflect the size and productivity distribution of stocks). Their results show that balanced unselective harvesting generates the highest yields; however, in comparison with unbalanced selective fishing (which is most similar to the current exploitation in the Baltic Sea), the maximum yield is only marginally higher in balanced unselective harvesting. Furthermore, the mean individual size in the balanced harvesting catches is much smaller and consequently less valuable on the current market.

Even though we understand the theory behind increasing yields by targeting the full size range in a population, <u>we do not believe it would be practically possible to implement a balanced harvesting approach in the Baltic Sea.</u> There are neither gears nor techniques for such an exploitation of Baltic fish today and considering the low market demands for juvenile fish (especially cod) for direct human consumption, it would most likely be much less profitable than allowing fish to mature before being caught.

<u>We agree with Jacobsen *et al.* (2014) and Maxwell *et al.* (2012) that a lot of uncertainties regarding ecological and socioeconomic consequences remain before such an exploitation concept can be considered in the context of ecosystem-based fisheries management.</u> In addition, even though most fisheries in the Baltic Sea only target a few species and Jacobsen *et al.* (2014) modelled different harvesting scenarios in a mixed fishery, it should be noted that under high fishing pressures unselective harvesting scenarios exhibited a "fishing down the food web" type of response, where the proportion of large-sized species gradually decreased.

7. ***Priority access to fishing opportunities should be given to the best performers. Proper Environmental Impact Assessments (EIA) should be conducted and fishing operators with the least environmental impact should be rewarded with priority access to fishing resources.***

The foundation of sustainable fisheries management in the EU is to limit catches in such a way that overfished stocks can recover, but how do we realise the overarching objectives of both sustainable use and marine conservation? Fisheries impact on the marine environment and this is not limited to the effects of removing a proportion of the targeted population. We need to explore ways to minimise those impacts through changes in techniques and behaviour. Such changes can be encouraged and supported by providing preferential access those who fish in the most sustainable way, based on environmental and social criteria. This is also in line with the regulation on the CFP, in which it is emphasized that Member States shall use transparent and objective criteria when allocating fishing opportunities, no longer limited to historical catches , thereby creating incentives to improve fishing practices and reduce the environmental impacts.

Such criteria could include: effects on target species (selectivity), proportion of unwanted catch, effect on habitats, efficiency in terms of catch per unit effort (CPUE), fuel efficiency, security for the fishermen and quality of the catch.

8. ***The multispecies plan must be adaptive and allow adjustments based on improved knowledge.***

Even though the Baltic Sea is considered a suitable pilot region for the development of multispecies management based on biological interactions, that does not mean it will be easy. For example, there are still considerable degrees of uncertainty of important knowledge to perform reliable stock assessments. This is most recently exemplified in the recent Baltic stock advice, where ICES failed to produce a reliable assessment for the eastern Baltic cod stock, but there are also uncertainties in the catch proportions of different species due to high levels of misreporting in the Swedish pelagic mixed fishery in the Baltic Sea (Hentati-Sundberg *et al.*, 2014).

There is however a rather unique situation with fishing targeted only towards one or a few species which naturally is of advantage when implementing the discard ban in Baltic fisheries which will be enforced for all commercial species (flatfishes excluded) from next year, 2015. It is therefore very important to design the discard ban plan for the Baltic Sea in such a way that we improve the data on overall fishing mortality. This information will also be useful in reviewing and improving the multispecies plan.

Furthermore, the discard ban will only include fish that are actually caught. However, there are other types of fishing mortality, such as that which occur due to fishing activities although those fish are not landed. This so-called “unaccounted discard” occurs in most fisheries, and improved data on the survival of underwater losses/escapees from the catch is necessary. Unaccounted discard is currently counted as natural mortality in the stock assessments, which creates a bias in the information on for example stock-specific productivity. Even if the current knowledge on the subject is poor, Surronen *et al.* (2005) show that the mortality of cods passing through the trawl can vary between insignificant to 15 %, depending on i.e. temperature. Although these numbers are only indicative, the unaccounted underwater mortality can be significant considering that the total biomass of cods passing the trawl is estimated to be significantly larger, e.g. 214 kg cod must have entered the trawl for a catch of 100 kg (Anonymous, 2013) and, if counting individuals, a multiple number of individuals passing the trawl compared with those who are actually caught.

However, this unaccounted discard is only studied for cods that have escaped during the actual towing phase. The survival of the large fraction of individuals that escape during the haul-back process, especially in side trawlers, has not been investigated at all in the Baltic Sea. There are reasons to believe that the mortality among these individuals is considerable, since the survival rate is dependent on the time that the fish has been trapped in the trawl. Most individuals actually escape through the trawl late in the fishing event, and a considerable part escape during hauling of the net (Herrmann *et al.*, 2013). In general, the survival rate is lower for exhausted individuals. Furthermore, when escapements take place at the surface, the fish are more likely to have experienced physiological damages due to the rapid and drastic change in water pressure (Tschernij & Holst, 1999). Thus, if the survival is low, this overlooked factor might constitute a significant and unaccounted discard of undersized cod.

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