Baltic Marine Environment Protection Commission

HELCOM Fish Correspondence Group concerning a draft document on BAT/BEP descriptions for sustainable aquaculture in the Baltic Sea region (CG Aquaculture)

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CG AQUACULTURE 4-2021

Document title	A further developed proposal for BAT/BEP to avoid or minimize nutrient pollution from aquaculture operations in the Baltic Sea region
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Note that this document was submitted after the established deadline. It will be decided by the Meeting whether the document can be discussed or is postponed to the next meeting.

Background

In 2016 the HELCOM Contracting Parties adopted Recommendation 37/3 on "Sustainable Aquaculture in the Baltic Sea Region". It recommends to develop BAT and BEP measures aiming at sustainable aquaculture in the Baltic Sea region based on guidance as contained in Annex 1 of Recommendation 37/3. The HELCOM HOD 54-2018 (Outcome § 4.57) requested the Contracting Parties to contribute to the work on BAT/BEP for sustainable aquaculture. Germany presented some initial ideas for BAT/BEP to avoid or minimise nutrient pollution at the CG Aquaculture 2 meeting in 2018 (see document 5-2 of CG Aquaculture 2). These recommendations were further developed based on a report by the AquaBioTech Group that was commissioned by Germany. The further developed recommendations were presented to CG Aquaculture 3 (see document 6-2 of CG Aquaculture 3) and were discussed in detail at the meeting. After CG Aquaculture 3, the Contracting Parties were invited to further comment on document 6-2. Comments were received by Sweden, Finland, Poland and FEAP. This document contains an overview of all comments received and an edited text proposal that takes the comments into account.

Action requested

The Meeting is invited to:

- take note and discuss the comments received and proposals for their consideration
- take note of and discuss the further developed proposal for BAT/BEP to avoid or minimize nutrient pollution from aquaculture operations in the Baltic Sea region
- decide on a way forward to finalize the work

A further developed proposal for BAT/BEP to avoid or minimize nutrient pollution from aquaculture operations in the Baltic Sea region

Germany presented some initial ideas for BAT/BEP to avoid or minimise nutrient pollution at the CG Aquaculture 2 meeting in 2018 (see document 5-2 of CG Aquaculture 2). These recommendations were further developed based on a report by the AquaBioTech Group that was commissioned by Germany. The further developed recommendations were presented to CG Aquaculture 3 (see document 6-2 of CG Aquaculture 3) and were discussed in detail at the meeting. After CG Aquaculture 3, Contracting Parties were invited to further comment on document 6-2. Comments were received by Sweden, Finland, Poland and FEAP.

In a first step concrete text edits and proposals were incorporated in the text in track changes (see column 1 “revised text proposal” in table 1 in Annex 1). As a second step, all comments received from CG Aquaculture 3 and in the commenting round were numbered and collated in a table (see table 1 in Annex 1). For easier reference all comments have been numbered. Comments that were straightforward to address were taken into account by making concrete changes in the text. Such comments are listed in column 2 “comments addressed”. More substantial comments and contradicting comments that cannot be incorporated without further discussion have been compiled in column 3 “Comments still to be incorporated including proposals for incorporation” of table 1. For the comments in column 3 suggestions have been made in “replies” of how these comments could be addressed. Issues suggested for further discussion in CG Aquaculture 4 are highlighted in bold. Concerning RAS the conclusions of the Finish Report (see document 4-2 of CG Aquaculture 4) have been incorporated.

The most prominent issues that require further discussion by CG Aquaculture 4 are the following:

- Need for drafting an introductory chapter that describes and evaluates the different aquaculture systems with respect to their properties and environmental impacts, possibly including a matrix or scoring system for their performance with respect to selected issues (environmental impacts, energy efficiency, water use, climate impacts etc.)
- Incorporate in the introductory chapter additional aspects of aquaculture systems such as climate impacts, energy and water use and scare land resources
- Further discuss and decide which aquaculture techniques constitute BAT under which environmental circumstances
- Consider under what circumstances to recommend fallowing
- Consider whether to recommend aquaculture management zones (AMZs)
- Consider what tool to use to limit nutrient inputs: setting production limits in AMZs and/or setting maximum allowable nutrient discharges
- Consider the new paragraph on BAT/BEP for open cage systems
- Specific issues on RAS, extractive aquaculture, mortality management, sludge underneath cages, fish feed type and feeding practices

Annex 1 Table 1
BAT and BEP measures aiming at sustainable aquaculture in the Baltic Sea Region

Note: Issues requiring further discussion are highlighted in bold

Revised text proposal	Comments addressed	Comments still to be incorporated including proposals for incorporation
General comments 1.Poland: Impact of the aquaculture sector should be viewed from the wider perspective as one of the sectors having an impact on the marine environment. At the same time, much higher impact caused by other sectors such as agriculture and coming from municipal purification plants should be examined. Only having full picture of different pressures influencing the status of the Baltic Sea environment, aquaculture can be considered as one of these elements. Any regulations and limitations put on the aquaculture sector should take into account the scale of the contribution of this sector to the marine waters' pollution. Also the analysis of any positive impact of the proposed BAT/BEP guidelines on the marine environment, should be carried out taking into account the scale of the other sectors contributing to the marine waters pollution. Furthermore PL underlines that BAT/BEP guidelines should aim at reducing the negative impact of aquaculture on the Baltic Sea environment. At the same time, the aim of the guidelines SHOULD NOT BE to limit the aquaculture production. 2.Sweden: The Swedish Board of Agriculture find it problematic that the proposal focuses strongly on nutrient pollution, at the expense of other important impacts of aquaculture, such as energy and water use, climate impact and use of scarce land resources. Unless the scope of this document is broadened, or it is supplemented by other guidance documents, this could have the effect of making environmental assessments less comprehensive. This could even support a development where one type of environmental pressure is reduced at the expense of others, equally pressing environmental considerations. In particular, we find that the complex issue of localisation of aquaculture operations warrants a more thorough consideration, not least since that is inextricably linked to the determination of BAT/BEP. Also, other factors, such climate impact, must be clearly included in any attempt at determining what constitutes BAT/BEP for different aquaculture operations. (See e.g. the definition of BAT in Directive 2010/75/EU on industrial emissions according to which it aims to 'to reduce emissions and the impact on the environment as a whole').		Reply to Polish comment: The work on BAT/BEP in CG Aquaculture should focus on the aquaculture sector. Other work in other HELCOM groups (e.g. WG PRESSURE) takes other activities that lead to water pollution into account. In general, the proposals for BAT/BEP are developed with due consideration of economic viability aspects of the aquaculture industry. Hence, this is already taken into account and there is no need for further changes in BAT/BEP measures. Reply to Swedish comment: The scope of the document was initially to focus exclusively on BAT/BEP to mitigate nutrient pollution from aquaculture. It was already discussed that other topics (e.g. hazardous substances, litter, non-indigenous species, monitoring) will be developed as well. The aspects of climate impacts, energy and water use and scare land resources were not yet discussed. It is valid to take these into account. **It is suggested to specifically consider these aspects when describing and**

CG Aquaculture: Mentioning of BAT/BEP in each sub-heading should be done consistently, and that it should be clear which sections concern marine aquaculture or land-based/inland aquaculture. 3.Sweden: The document aims to be a proposal for the Baltic region. However, both the term Baltic Sea region and Baltic Sea, is used throughout the text. It is important to clearly define the geographical areas as well as the water biotope types that are included and targeted in the proposal. 4.FEAP: There is on huge issue missing in this document. Since no other technology, for the time being, can be considered BAT/BEP for farming cold water fish for consumption (about ≥ 1 kg), the emission to farm fish in open cages and the different kinds of development that are being made to reduce environmental impact from this technology is totally forgotten in this document. This include feed development, possibilities to collect sludge under the cages, triploidization of fish etc		**evaluating the different aquaculture techniques in chapter 1 and the siting of aquaculture operations in chapter 2. Germany would need support in drafting this.** Reply to comment by CG Aquaculture and Sweden: These are mainly editorial issues that will be taken into account at the end. It needs to be ensured that it is clear which recommendations relate to land-based/marine system and to the Baltic Sea/Baltic Sea region. Reply to FEAP comments: It needs to be further discussed whether there is no alternative to open cage farming for cold water fish. Concerning BAT/BEP for open cage farming this is already addressed, including feed composition and sludge collection. A new chapter on open cage systems has been drafted by Finland. Triploidization could be addressed when dealing with the topic of non-indigenous species.
1) **Aquaculture systems**		
There exist different aquaculture systems that differ in their degree and character of environmental impacts they are causing. In order to minimise such environmental impacts the following needs to be considered for the marine environment: • Concerning land-based aquaculture Recirculating Aquaculture Systems (RAS) are preferable to flow-through ~~and pond~~ systems since less waste water is discharged and effluent water can be treated in a more effective way (see chapter 2.1)		5.CG Aquaculture: Redraft as a more general introduction (not only linked to nutrients), listing various aquaculture systems, also adding missing types of systems such as natural ponds. Natural ponds with fish farms may be Natura 2000 sites and

• Development and intensification of freshwater pond-based aquaculture should include IMTA-like production strategies provided that its implementation will consider the following measures: circular economy principles, multiple re-use of water (RAS-like management of water of pond systems), integration of RAS and extensive production strategies for different life stages of different species (which would enable species diversification of such a production system). Such an approach could also integrate various agricultural activities aiming at utilization of biogenic compounds (including silt and sediments) and thus reducing negative impact of the production • ~~The cultivation of marine species in~~ RAS systems provide better possibilities of controlling nutrient flows compared ~~is generally preferable~~ to open cage aquaculture in the Baltic Sea; a combined approach is also possible, where fish, e.g. Rainbow trout, could be initially cultivated in RAS until they reach a certain size and are then transferred to net-pens or cages in the open sea • Semi-enclosed containment systems (S-CCS) and even closed containment systems (CCS) could be used for the cultivation of Atlantic salmon and possibly for Rainbow trout and are preferable to open cage aquaculture, but they cannot yet be considered BAT • Integrated multi-trophic aquaculture (IMTA) combining the cultivation of organism from different trophic levels are preferable to open cage aquaculture, but they cannot yet be considered BAT		may actually have environmental effects that are seen as beneficial for the specific site through improving biodiversity. Reply: **needs to be drafted by someone knowing the different aquaculture systems well. Germany needs support with this section.** 6.CG Aquaculture: Proposal to include a matrix or table in the document, describing what measures are feasible for different types of aquaculture and including a scoring system for their performance **Reply: Matrix should be drafted, also incorporating aspects such as energy efficiency, climate impacts, water and land use. Germany needs support with drafting this.** 7.Sweden: To our mind, BAT/BEP cannot be determined in abstracto for a whole category of aquaculture operations, without consideration of the specific conditions applicable at each specific site. It is thus problematic that this is done with respect to (S)-SCC and IMTA and that open cage systems are not mentioned at all. Although the document seems to acknowledge that RAS can constitute BAT/BEP, we lack a clearer emphasis on place specific conditions for the determination of RAS as BAT/BEP. While open net pen aquaculture can very well remain BAT in oligotrophic

		waters, solutions such as RAS, SCC or IMTA must be considered as potential BAT/BEP in waters already subject to high nutrient loads. But that determination must also be cognizant of the relative contribution of such technologies to other environmental pressures. We find it vitally important that a document like this supports a dynamic development of increasingly sustainable aquaculture technologies and practices. To fill that purpose, it must first of all recognise that RAS, SCC and IMTA are all complex concepts capturing a diverse set of dynamic technological solutions. To make general conclusions as to whether any such category of aquaculture technologies would constitute BAT or BEP in general fails to consider the great variety of both cost and technological maturity within these categories. Any such general statements also risk counteracting the dynamic development of sustainable technologies and the attendant adjustment of regulatory requirements. Reply: There is the need to couple specific recommendations for selected aquaculture systems with considerations of site conditions. **A more differentiated approach and more discussion is needed to decide which aquaculture systems to recommend as BAT under which conditions.**

		8.FEAP: RAS cannot, for all species and locations, be considered BAT. Reply: see above
2) **General management measures to avoid or minimise nutrient pollution**		
BAT/BEP for ~~S~~siting of aquaculture operations, in particular in the marine environment Locating aquaculture operations appropriately is very important and strategic planning can avoid or minimize many of aquaculture's environmental impacts. Therefore, the following needs to be considered for the marine environment: • The area should have ~~adequate~~ sufficient current speeds ~~(mean 25-50 cm/s, max 60-75cm/s)~~ to prevent localised nutrient accumulation; while dispersive capacity increases with current speed, aquaculture farms should not be located in areas where the flow rate is too high for optimal growth and FCR, and for the maintenance of good fish welfare and the integrity of the farming infrastructure • For bivalve cultivation, the current speed ~~must~~ should not surpass that at which bivalves are capable of settling and intercepting food items ~~(mean speed of 25 cm/s using long-lines)~~ • A minimum water depth required for finfish net-pens and suspended shellfish cultivations should be applied in plans for siting ~~determined~~ to help prevent localised accumulation of solid waste upon the benthic zone below aquaculture facilities as deep water increases the likelihood of dispersion and assimilation • [[New] intensive finfish production and shellfish cultivation should not be established in areas with [severe] eutrophication~~-~~ that are characterised by bottom oxygen deficiency and heavily impacted benthic zones (e.g. high sediment nutrient content, anoxia/hypoxia, sulphide production)] • Site selection should take the assimilative capacity or carrying capacity of the environment into account, which is defined as the amount of pollutants that can be processed without causing high concentrations and non-compliance with water quality standards of WFD, MSFD and HELCOM; to determine the assimilative capacity of the environment as well as the impact of aquaculture and its significance	9.CG Aquaculture: modelling of impacts of nutrient discharges should be considered 10.Sweden: Current speed may hold for nutrient dispersion but considering fish welfare it is very much dependent on size of fish and life history to conclude which is ok, the max is defenitly too high for newly stocked fish and depending on stocking size even the mean may be too high. 11.Finland: Figures for current speeds should not be given, the notion of adequate current speed is sufficient and can be considered in the permit procedure for each site locally. 12.FEAP: No exact values for current speed should be given. Especially when it comes to inland farming in fresh water and further in	14.CG Aquaculture: synergies with other businesses in the area should also be considered. Reply: **unclear what is meant. Examples for such businesses need to be discussed.** 15.CG Aquaculture: consider including a map of potential areas for marine aquaculture, or alternatively principles of such mapping. **Reply: it would probably be difficult to include such a map. Maybe VASAB could be approached but it is unlikely that all CPs have already designated areas suitable for mariculture in marine spatial planning.** Principles of mapping are already indirectly incorporated by recommending issues to take into account for siting aquaculture operations.

for the essential water quality factors, models together with expert assessments for site selection and permit procedures ~~e~~should be used • Site selection could be supported by modelling approaches that predicting nutrient dispersion, solid deposition and the assimilative and carrying capacity of the receiving environment • Site selection should be supported by using hydrodynamic and ecological modelling that allows a prediction about the area of potential impact, considering both near-field and far-field impacts • Site selection also needs to take into account, but is not limited to, the "HELCOM / VASAB Baltic Sea broad scale marine spatial planning principles" and the "Guidelines for the implementation of the ecosystem-based approach in marine spatial planning in the Baltic Sea area" as well as specific socio-economic issues of importance to aquaculture and other regional stakeholders • Specific aquaculture management zones or localisation plans may be established for aquaculture operations in the Baltic Sea in particular for new aquaculture operations and for the extension of existing ones • New ~~F~~fish farms should not be placed in protected areas if they might compromise conservation objectives for which MPAs have been established • Potential negative impact of aquaculture facilities located outside ~~MPAs~~ protected areas on these protected areas (in particular, HELCOM MPAs, NATURA 2000 sites, RAMSAR and potential MPAs as designated under MSFD Art. 13 (4)) or other ecologically sensitive areas should be assessed and avoided	hydropower magazines were the lower currents leads to a higher phosphorous retention and less nutrient transport to the Baltic. However the local current speed still needs to be adequate (high enough) for optimal conditions for the fish. 13.FEAP: The water depth will never be large enough to prevent localized accumulation. Not without a combination with currents that are too strong for good fish welfare and the integrity of the farming infrastructure. (Not even the depth and tidal currents in Norway etc, prevents local accumulations). However, a minimum water depth might yet be required for BAT/BEP.	
General management of nutrient related impacts upon the benthic zones and the water column • Where justified and possible, ~~I~~implement ~~and coordinate~~ fallowing periods [where it is supported by scientific evidence on overall and significant environmental benefits], the length of which should be determined based upon the assimilative capacity of the benthic zone and other environmental impacts and assessed as a part of the permit procedure	16.FEAP: If moved in appropriate intervals, oxygen deficiency can be avoided and thus the mount of phosphorus released minimized. That should be better for both the local area and the Baltic as a	18.CG Aquaculture: Legal requirements and licensing procedures, which may differ between Contracting Parties, need to be considered in the context of fallowing. From the technical scientific point of view, fallowing may not be the most suitable measure, and consideration should rather be given to the

• Fallowing periods may also have benefits in relation to reduction of diseases at the site • The most relevant site specific nutrient related impacts have to be defined and monitored on farm level (see chapter on monitoring and reporting requirements, to be drafted later) • Consideration of suitable waste management practices (see chapter 3) and suitable fish feed type, fish feed composition and feeding practices (see chapter 4)	whole than ”sacrificing” certain areas. 17.CG Aquaculture: Fallowing periods may also have benefits in relation to reduction of diseases and viruses at the site.	environmental carrying capacity of the specific site. No case studies on the effects of fallowing are available from the Baltic Sea region. Reply: **There are generally different opinions in CG Aquaculture on the issue of fallowing periods. Further discussion is needed on how this should be addressed. Is it sufficient to recommend fallowing “where possible and justified”?**
Establishment and operation of aquaculture Management zones • Specific Aquaculture management zones (AMZs) [should]/[may] be established for aquaculture operations in the Baltic Sea where this is not yet incorporated in national regulations, in particular for new aquaculture operations and for the extension of existing ones • AMZs are an appropriate tool for managing the impacts from aquaculture operations beyond the farm scale • AMZs are particulary important for open cage finfish aquaculture but could also incorporate nutrient extractive aquacultures with a few to compensate for nutrient inputs from open cage cultures General Environmental Impact Assessments (EIA) should be conducted to support the designation and management of AMZs • The EIA should be based upon site-specific data, accompanied by appropriate modelling approaches and should focus upon near-field impacts as well as far-field impacts, covering the following aspects: - Benthic characteristics and water quality - Ecological/environmental status of the site according to WFD/MSFD and HELCOM - Prevailing surface and subsurface water current direction and velocity	19.CG Aquaculture: Merge AMZs chapter with chapter on siting. Reply: Editorial, will be done at the end. 20.CG Aquaculture: Added value of AMZs as compared to existing national and regional regulations is somewhat questionable, as the same elements are already incorporated in such regulations. AMZs may have advantages if several aquaculture operations are located in the same area or near national borders, as management and monitoring could then be coordinated. AMZs would be a tool for monitoring	22.Poland: PL does not support setting any production limits, including limiting biomass production. Innovations and technological progress allow the development and increase of production volume without increasing a negative impact on the environment (Recirculation systems – RAS, higher digestion and assimilation of fish feed, lower content of marine origin ingredients in fish feed etc.). Increase of production in aquaculture is a strategic aim of the EU for the coming years, as the aquaculture is one of the most environmentally effective source of proteins for human consumption, there is also a constant desire for self-sufficient supply of the union market in fish products and fish (currently more than 60% of the fish products consumed by EU citizens are coming from outside the EU). In the opinion of Poland, limits can be put on emissions,

- Modelling approaches for predicting nutrient dispersion, solid deposition and the assimilative and carrying capacity of the receiving environment (e.g. DEPOMOD) • AMZs should be located in areas with adequate environmental, production and social carrying capacity • AMZs for open cage finfish aquaculture should not be located in Marine Protected Areas and should not be located so that the ~~environmental impacts reach~~ MPAs are [significantly] negatively impacted by the aquaculture • The number of AMZs within any given area, and the distances between each AMZ should be defined whilst taking into account carrying capacities • The designation of AMZs requires stakeholder consultation and participation as part of local and regional integrated ecosystem management strategies • Production cycles and harvesting periods between the same or different producers ~~should~~ may be coordinated within an AMZ In addition, the recommendations for the general management of nutrient related impacts upon benthic zones and the water column provided above also apply to AMZs.	cumulative impacts from aquaculture beyond the farm scale. 21.Sweden: Since the environment impacts of aquaculture differ (finfish, algae, bivalves.) It would be appropriate to define what kind of production the AMZ refer to.	but not the volume of the aquaculture production itself (regardless if this is marine aquaculture or inland aquaculture). **Reply: Further discussion is needed on whether and how to recommend AMZs. Germany suggests to recommend both – setting emission limits and establishing AMZs to tackle cumulative impacts.**
Defining maximum allowable production in AMZs Coordinated production in AMZs csh~~h~~ould be done within the context of a defined maximum allowable production, as a means of limiting nutrient discharges and reducing the risk of disease outbreaks. This concept could replace~~s~~ the average nutrient discharge limits per live weight (kg) of fish contained in HELCOM R~~r~~ecommendation 25/4, since these are difficult to determine, ineffective from the perspective of environmental protection and impossible to enforce or sensibly monitor. For each AMZ a maximum allowable production should be defined considering the following principles for the open Baltic Sea and for coastal areas: For the open Baltic Sea (>1 nautical mile) • If possible, the AMZ should not be established in a Baltic Sea basin that is subject to eutrophication, as assessed by HELCOM • If an AMZ is managed collectively by different HELCOM Contracting Parties the basis for the definition of the maximum allowable production are the **maximum**		23.CGAquaculture: different views on what approach to take, focusing on maximum allowable nutrient discharges, maximum allowable production or other aspects. This should be decided based on national legislation. As various approaches are stipulated in the national legislation of Contracting Parties, the document should take this into account. The concept of average nutrient discharge limits per live weight (kg) of fish contained in HELCOM Recommendation 25/4 provides an incentive to develop the aquaculture procedures to reach the set limits

allowable inputs (MAI) of nitrogen and phosphorus that have been derived for the basin where the aquaculture operation is based in • If an AMZ is managed by only one HELCOM Contracting Party the basis for the definition of the maximum allowable production are the **national nutrient input ceilings (NICs)** for nitrogen and phosphorus of this respective Contracting Party for the basin where the aquaculture operation is based in • MAI or NICs need to be considered so that the prognosed additional nutrient discharge from an aquaculture operation does not lead to an exceedance of MAI or NICs For coastal areas (<1nautical mile) • If possible, the AMZs for finfish aquaculture should not be established in a WFD water body that is subject to eutrophication, as assessed by HELCOM or that fails to achieve good ecological status as assessed by the WFD • The transport of nutrients to the open Baltic Sea basins needs to be considered and should not lead to an exceedance of the national NICs • The European Union Court of Justice ruling that Member States may not authorise projects that lead to a deterioration of the status of a water body, even on a temporary basis, unless a derogation is granted (the Weser case) should be considered when establishing AMZs in WFD water bodies Within an AMZ the production can be limited based upon the principle of maximum standing biomass with repeated cropping of desired size classes or on an all-in-all out approach. If the setting of a maximum allowable production is not possible, defining a maximum allowable content of N and P in feed, or setting a maximum allowable bFCR) (biological Food Conversion Ratios = quantity of feed consumed by a fish that is converted to growth) are second best alternatives. If limits for feed or maximum allowable bFCRs are used, the following principles apply: • Limits to feed nutrient content must be defined for feeds intended for specific cultivation types and environments, different life-stages/age and size classes, and different species		which, however, should be made more ambitious than in the Recommendation. In the new Estonian national legislation the licencing organization sets the maximum nutrient limits, taking into consideration the maximum carrying capacity of the area. Compensation methods or improved technology can be used to increase production. Further useful information can be found in the Aquaculture Toolbox which was launched by the TAPAS H2020 project. 24.CG Aquaculture: For coastal areas national legislation already exists and needs to be taken into account. 25.Poland: We definitely support the use of the N and P parameter in feed or/and Food Conversion Ratios - FCR. Development in fish feed formulas is so significant that the definition of the maximum allowable production does not reflect the impact of fish breeding on the environment, but only artificially reduces the opportunities for the development of aquaculture.. The maximum allowable production parameter may have an opposite effect. In case the amount of allowable biomass is reduced, it can be achieved by using cheaper, worse kinds of fish feed with worse factors. The aim of the proposed measures should be to reduce impact on the environment but

• Maximum allowable bFCRs must be defined according to cultivation environment and species • The differentiated considerations for open Baltic Sea basins and coastal waters detailed above also apply Stakeholder consultation is the best route towards ensuring that any limits set are realistic, implementable, and effective, whilst reducing stakeholder conflict and increasing cooperation. Producing companies should be consulted to ensure that approaches to limiting biomass production, content of N and P in feed or bFCR satisfy their intended purpose whilst being amenable to efficient and profitable production practices. **Maximum allowable nutrient discharges** An alternative tool to limiting biomass production are setting maximum allowable nutrient discharges at farm level. Average nutrient discharge limits per live weight (kg) of fish could be set. This would also provide an incentive to increase the nutrient use efficiency at farm level. It also enables the use of compensation methods or improved technologies in order to increase production.		not to reduce innovations in aquaculture. 26.Finland: Finland has a reserved position to the concept of AMZ and would rather propose that they are presented as an option and that the details on production limits etc. are replaced with more general formulations. Further discussions on the concept are needed. 27.Poland: Taking into accounts the arguments mentioned above concerning the development of the fish breeding technologies, water filtration systems, production and composition of fish feed, PL does not agree on using any limits for allowable biomass production or limits for quantity of feed used per site in Individual farm permits. This is not fully adequate to the impact of aquaculture systems on the environment. This is also in contradiction with the current EU policy which supports the development of aquaculture, as this is a food production sector that produce animal protein to be eaten by humans in a way having the smallest impact on the environment. This point defined as such, closes the opportunities for aquaculture sector to develop further. 28.FEAP: Maximum allowable nutrient discharges. Its important to encourage the fish farmer to make the production

		more environmental (nutrient) effective (better feed, better FQR and better management). The setting of maximum allowable nutrient discharges solves all of this and is equal to all production techniques. Reply to all comments: **Further discussion is needed whether and how we should recommend biomass limits in AMZs and whether we should re-introduce the concept of maximum allowable nutrient discharges as an alternative. If we decide to include this concept it would be useful to revise the limits per live weight (kg) of fish contained in HELCOM Recommendation 25/4.**
BAT/BEP for Aquaculture in open cages (Preliminary text by Finland based on Helcom rec. 37-3) Producing fish in open net cages causes nutrient discharges, which may have environmental impacts. Such environmental impacts should be controlled by applying the following BAT/BEP: 1. Establish new or enlarge existing aquaculture facilities only upon granting permits or according to prior regulations by the competent authority or appropriate body in accordance with existing legislation (including EIA and SEA directives for EU Member States) and taking into account the following aspects: a) when establishing aquaculture facilities, negative local environmental effects and threats to biodiversity should be avoided or minimized by careful planning processes including environmental impact assessment according to international, EU and national legislation as appropriate, and by selection of appropriate locations by means of objective environmental	29.CG Aquaculture: Finland offered to contribute with text related to open cage systems.	

impact evaluation methods taking into account the hydrographic and hydrological conditions of the specific water area; b) permits or regulations should aim at limiting emissions and discharges of phosphorus and nitrogen, thus striving to contribute, together with other sectors, to keeping the inputs within the Maximum Allowable Inputs as agreed in the HELCOM Ministerial Declaration 2013 (and following updates) in order to enable and not jeopardize the achievement of a good environmental/ecological/chemical status as agreed upon in HELCOM BSAP and relevant national, EU and international legislation; c) such permits or regulations should, inter alia: i. take due account of the current status of the marine and fresh water area potentially affected by the aquaculture facility and other sources of nutrient release or negative environmental effects; ii. take into account the carrying capacities of the directly affected ecosystem; iii. avoid or minimize negative impacts on the current status of the environment and aim at not jeopardizing the achievement of a good ecological/environmental/chemical status of the area affected, and d) evaluate future environmental effects of the proposed aquaculture facility as part of the authorization process for aquaculture; e) take into account aquaculture intensity, the type of cultured organisms and the production method, the hydrographic framework according to the Ecosystem Approach; 2. Supervise the discharges from and the ecological effects of aquaculture farms, e.g. by means of regular monitoring and e.g. aquaculture farm operation records, discharge calculations, monitoring and environmental impact models. Focus the monitoring on measuring reliably and cost-effectively the impacts of fish farming on the marine and fresh		

water environments, including the eutrophication status, oxygen depletion and the state of the sediments in the affected area. 3. Encourage the aquaculture sector to develop and to implement environmentally friendly technologies, production methods and feeds through appropriate incentives, e.g. incentives for a circular economy through the recycling/extraction of nutrients or development of semi-enclosed containment systems (S-CCS) or closed containment systems (CCS). 4. Encourage development and innovation towards ecologically sustainable farms and aquaculture technologies, including nutrient neutral and nutrient extractive ones, to avoid or minimize, and mitigate discharges of nutrients, organic matter, litter, chemicals and handling of escapees and diseases, as relevant.		
BAT/BEP for Recirculating Aquaculture Systems (RAS) Water ~~filtration~~ treatment prior to its reuse is ~~the definingone~~ of the feature of RAS. The main driver behind RAS development is limited water availability, rather than the control of nutrient discharges. Typically, RAS has two primary water flows. A smaller volume consists of sludge originating from sedimentation systems, particle filtration and system backflush and has high percentage of phosphorus and organic matter. A larger volume of water has lower solids level but contains most of the nitrogen discharge. These two streams, "sludge" and "overflow", are typically processed separately to reduce RAS nutrient discharges. The degree of water re-use intensity defines the water treatment steps necessary for maintaining good water quality for fish growth and welfare. Water use intensity also plays an important role in the nutrient capture efficiency, the more intense the water use, the higher are the concentrations of nutrients in the water and sludge streams, and higher reductions are possible than in larger water and sludge streams. However, a fraction of cultivation water is always discharged (e.g. 5-10% of total water volume), so that RAS systems cannot be considered as fully closed, thereby still causing local environmental impacts that necessitate effective and costly discharge control technologies. ~~Such e~~Environmental impacts of RAS should be reduced by applying the following BAT/BEP: • Optimised feeding using feeds purposely developed for use in RAS to reduce nutrient discharges (see also chapter 3)	30.FEAP: Sludge is not treated by filtration, but produced by filtration (and flocculation). 31.Poland: PL supports the qualification of sludge coming from aquaculture facility as an agriculture fertilizer, as in the case of every other animal breeding. Currently, such a practice is not covered by the relevant EU legislation. However Poland would welcome any legal changes to cover this gap.	32.Poland: BAT/BEP should rather focus on the aims that should be achieved and at the same time should not propose in detail concrete technical or/and technological solutions that should lead to their achievement. Technologies and innovations are very much needed including reducing the impact on the environment. As a result, the suggestion that mechanical filtration and biological filtration should be used, disregard the other useful and valuable technologies from including them to BAT/BEP. Taking the above into account we propose small amendment of this recommendation. Reply: **Needs further discussion. The aim is to develop not only BEP, but also BAT, which ultimately means recommending certain technologies that are established, economically**

• [Effluent water of RAS should be treated on site by biological denitrification technologies] (important for fish welfare but minor impact on nutrient discharge reduction) • Sludge of RAS should be treated on site by ~~mechanical filtration [~~ effective water treatment systems or sedimentation; constructed wetlands and woodchip reactors could be used as settling ponds • Sludge (nutrient containing solid wastes e.g. fish faeces and uneaten feed) ~~separated from water by mechanical filtration~~ should be used~~considered~~ as a ~~potential~~ fertiliser provided that it is not contaminated by hazardous substances~~(e.g. input to compost production or feedstock to biogas production)~~. To enable such use, possible EU legislation gaps need to be closed in this respect. CO_2 emissions are higher in RAS production compared to flow-through and cage farming operations. This is due to energy intense technologies, especially water pumping, temperature control of the water and building, and other technologies. In general, for the Baltic Sea Region there are few RAS farms that currently operate economically sustainable. The technology is still developing and cannot yet be regarded as BAT.		**viable and are proven to be most effective in minimising environmental impacts**.
BAT/BEP for flow-through tanks and pond systems • Individual farm permits should in the first place define a ~~maximum allowable biomass production (e.g. a maximum biomass allowable on the farm at any one moment, a maximum yearly production)~~ maximum level of nutrient discharges and alternatively ~~or~~ a maximum allowable quantity of nutrients in feed used per site or maximum allowable biomass production (e.g. a maximum biomass allowable on the farm at any one moment or a maximum yearly production) depending on site-specific conditions and environmental considerations • Water discharged from flow-through systems should be treated by sedimentation or [mechanical filtration and preferably also by biological filtration]/ [effective discharged water treatment systems] to ensure that the emission limit values do not exceed the environmental permit levels • Sludge from flow-through and pond systems should be used as fertiliser		

BAT/BEP for nutrient extractive aquaculture Culturing mussels or seaweeds does not release additional nutrients into the marine environment but reduces nutrients through harvesting of the cultured species. It can thereby help to combat eutrophication (see e.g. the findings of the Baltic Blue Growth project https://projects.interreg-baltic.eu/projects/baltic-blue-growth-11.html). However, conditions in the Baltic Sea are not everywhere suitable for culturing nutrient extractive species. Mussel cultivation is only feasible in the Western Baltic Sea where salinity is sufficiently high. Nevertheless, such aquaculture is not without impacts. With respect to nutrient pollution, mussels excrete faeces and pseudofeaces and their accumulation underneath the farm can cause undesired impacts on benthic habitats (e.g. through oxygen depletion). Therefore, the following principles apply: • [Extractive aquaculture in the Baltic Sea is in general preferable over finfish aquaculture] • Stocking densities of mussels need to consider the assimilative capacity of the marine environment • Models should be uess~~u~~ed to determine the assimilative capacity of the environment as well as further environmental impacts of bivalve aquaculture (e.g. ShellSIM, ShellGIS, FARM) • It should be avoided that mussels fall off culturing ropes • Environmental monitoring of the impacts on benthic habitats should be carried out (see chapter on monitoring and reporting requirements, to be drafted later) • Nutrient extracting species, such as bivalves and seaweeds, ~~should~~ may be used as part of a mass balance approach to compensate for the nutrient inputs of finish aquaculture	33.CG Aquaculture: Having nutrient extracting species as a nutrient compensation method is not possible in the northern parts of the Baltic Sea. 34.FEAP: Using mussels and seaweed as extracting species is also in line with the "new" Minister Declaration - Our Baltic 2020 Annex 1 p. 7 "We will PROMOTE ecologically sustainable sea-based measures, where appropriate with potential for eutrophication abatement such as mussel cultivation and blue catch crops." 35.FEAP: A reference can be made to the EU-project BBG Baltic Blue Growth . It showed how mussel growing can help fight euthrophication.	36.Finland: Text should say something about seaweed aquaculture impacts also. **Reply: needs to be further discussed. What impacts should be mentioned?**
3) Waste management practices Aquaculture activities, such as farming, slaughtering and processing, produce 'biowastes' which are particular to the aquaculture sector. Such waste may be a vector of diseases when and if it is disposed directly to the aquatic environment. Proper waste management can contribute to reducing environmental impacts of aquaculture activities in the Baltic Sea		

through waste recycling as well as valorisation of wastes which may also create an income to the farmer or reduce disposal costs. BAT/BEP is defined in the following for mortality management, waste underneath open cage farms and aquaculture processing wastes.		
Mortality management • Dead and moribund fish should be collected immediately and regularly to prevent the spread of pathogens, both within the aquaculture and the natural environment • If ~~mortality~~ dead fish cannot be removed immediately from site and transported to a treatment facility, ensiling is preferable, both as a method of storage and partial inactivation of pathogens • [All collected mortality should immediately be stored within sealed containers that need to be thoroughly cleaned and disinfected after use] • ~~[~~In net-cage/pen cultivation, the net should be designed and managed to facilitate the collection of dead fish ~~conical shaped bottom nets should be used instead of flat bottom nets, as they facilitate the recovery of dead fish~~] • [Mortality collection systems should be installed within net-pens to facilitate the regular removal of dead fish and reduce dependency upon divers] • The volume of mortality ~~production~~ should be recorded and all stored and transported ~~mortality~~ dead fish should be clearly labelled (including information on the date when the dead fish are put into storage, the destination, date of collection and relevant details of the receiving entity)		Reply: **Further discussion is needed whether to delete the points in square brackets**
Waste underneath open cage farms in the marine and freshwater environment • Appropriate fallowing periods should generally avoid the accumulation of sludge underneath open cage farms • [If ~~S~~sludge accumulates underneath farms, it should ~~could~~ be removed regularly if this has environmental benefits]	37.CG Aquaculture: Depending on the removal technique, this might also create additional environmental impacts 38.FEAP: Removal will lead to additional environmental impacts.	

	Appropriate fallowing periods will lead to natural degradation of this organic material and removal will not be necessary. This can also be valid for fresh water farming in cages.	
Aquaculture processing wastes • Primary (including slaughtering) and secondary processing [without a permit] should not take place at sea, either upon or adjacent to sea-based farm sites • When economically and logistically practical, and when regulations allow, aquaculture processing by-products should be utilised or otherwise valorised, rather than disposed • Wastewater discharges from processing should have minimal solid and dissolved nutrient wastes and have an acceptable biological and chemical oxygen demand • Discharges should have characteristics that do not exceed the assimilative capacity of the environment • BAT should be implemented to clean the processing wastes depending upon the case specific characteristics of waste and wastewater produced (e.g. flocculation and coagulation, or flotation methods should be employed to remove fats and oils, use of ozonation to inactive pathogens, biological filtration to remove solid and dissolved nutrients) • Wastewater quality parameters should be monitored daily and fully recorded		**Reply: Still prefer to generally recommend that processing should not take place**
4) Fish feed type and composition and feeding practices Fish feed in general should promote good health and fish well-being. ~~A basic knowledge of aquaculture feed and feeding strategies is important for understanding how nutrient emissions from aquaculture can be minimised. This is because~~Fish feed type and feeding methods influence the amount of feed that is offered to fish, the amount of feed remaining uneaten, and the proportion of nutrients within the feed that are undigested and ejected as waste. Furthermore, the supply of feed ingredients is associated with environmental impacts. Sustainable fish feed composition should be promoted to reduce the general		39..Sweden: Writing that sustainable feed should be used to reduce the pressure on wild fish and reduce nutrient leakage is very narrow. There are several other sustainability factors that should be taken into consideration in this context.

pressure on wild fish stocks and reduce the inflow of nutrients from outside the Baltic Sea region and to prevent ~~additional~~ nutrient discharges by optimizing feed formulations to nutritive requirements and retention of nutrients and achieving improved bFCR. BAT/BEP is defined in the following for feeding strategies, fish feed type and composition and fish feeding practices.		**Reply: Unclear what other sustainability factors should be considered – to be discussed.**
Feeding strategies • The aim should be to obtain a bFCR of close to 1:1 while considering aspects of the economic viability of aquaculture operations • Economic fee~~oo~~d conversion ratios (eFCRs) (bFCR plus mortaility and uneaten feed) should also be close to 1:1 while considering aspects of the economic viability of aquaculture operations		40.FEAP: FCR is dependent on the size of the fish, an FCR = 1 for large fish size 1 – 4 kg is not realistic. **Reply: This is phrased sufficiently soft "aim is to obtain…close to.." and not as an absolute value that needs to be achieved.**
Fish feed type and composition • Nutrient discharges could generally be reduced by optimizing nutritive requirements • Only ~~certified~~ quality feeds should be used with formulations that are easily digestible and have a nutrient profile that supports maximum retention efficiency in fish • The feeds need to be specific to the species being cultivated and the size/life stage of the stock • Fish stocks should be uniform in size to improve the accuracy of size specific feed types and feeding regimes; periodic grading should be used to enable the sorting of fish into cohorts of similar sized individuals if dominance hierarchies prevent an optimal FCR from being achieved • Trash fish (forage fish that are fed direct to carnivorous aquaculture species) should not be used as feed • Handmade or manufactured moist feed should not be used in intensive open cultivation systems • Fishmeal and fish-oil in the diets of carnivorous marine species should be ~~partially~~ replaced using alternative ingredients under the condition that this does not reduce	41.Sweden: Mussel meal can be a good alternative, SE has worked a lot with mussels as feed. However, there is still some work to be done, e.g. how the taste of the fish is affected. One of the ocjection is whether it is possible to buy any larger volumes of mussel meal to have in fish feed. 42.Poland: Does "certified quality" apply only to commercial feeds? If so, then what about feeds produced by a fish farmer on the spot? It would be good if the farmers who produce the feed themselves could in some legalized way obtain a	45.FEAP: Does the replacement of wild fish in feed relate to all wild fish? Including fish from the Baltic that are not fished for consumption and that helps extracting nutrients from the sea? Or wild fish from outside the Baltic? **Reply: Suggest to not specifically recommend producing fish feed from non-commercial Baltic Sea species for the purpose of removing nutrients since such fishery constitutes a biomanipulation and still has environmental impacts.** 46.FEAP: No specific raw materials need to be mentioned when it comes to replacing the amount of wild fish in the feed. Refer to compensation production for removal / harvest of proteins (uptake of phosphorus and

the performance (growth, FCR, quality and welfare) or quality of fish or [production costs] or leads to increased environmental impacts • 'Finishing diets,' with higher inclusion rates of fishmeal and oil, and used for a period before harvesting, can be used if necessary • [The amount of wild fish in fish feed should generally be reduced and be replaced by alternative ingredients, ~~preferably~~ [for instance by mussel meal from mussels cultured in the Baltic Sea or trimming] • While efforts to identify novel feed ingredients are encouraged, they should not be used until their efficacy and safety as well as their environmental effects have been demonstrated • Fish feed should use regionally sourced products such as sustainably harvested fish and other protein sources in the Baltic Sea region as ingredients to decrease the net inflow of nutrients into the Baltic Sea region and reduce the use of ingredients from areas outside the Baltic Sea region • ~~If wild fish is used as an ingredient in fish feed, stocks need to be harvested sustainably and it is preferable to use sustainable sources such as fish processing wastes~~ • [Landed bycatch should not be used for fish feed production since this might counteract the pressure to minimize bycatch in fisheries]	"certificate" for it and thus meet the requirements. 43.Poland: What about fish species for which there is no dedicated feed, e.g. pikeperch or Eurasian perch? 44.FEAP: Certification does not make sense.	nitrogen). Choice of raw materiel should be driven solely by quality and market price. Then certifications must be made to promote local raw materials or simply claiming that they are sustainable. **Reply: Suggest to still refer to mussel meal as a potential alternative as also suggested by Sweden.** 47.FEAP: So landed bycatch should better just be thrown away? Why not includes but without gaining any net income for the fisher? **Reply: Needs further discussion, there were also proposals to completely delete the bullet point on landed bycatch**
Fish feeding practices • Feed should be stored within an appropriate environment with suitable levels of humidity and temperature to ensure that nutritional quality and palatability are maintained • Feed bags should not be left open and unattended on fish farms, to prevent birds from eating and spilling their contents • Feeding decisions should be made by knowledgeable and experienced staff • While the tables provided by feed manufacturers which estimate the quantities of feed required for optimal FCR and growth rate should be followed, informed adjustments to feeding quantity and rate may be necessary	48.FEAP: Most Trout farmers use surface feeding responses as the main means of judging ration size. No improvement by using underwater cameras has been proven on trout. The manager must feed at the forefront of variations in temperature or oxygen. Measurement of oxygen and temperature along with weather forecast and ocean	

• The feed quantity should be determined considering parameters such as water temperature and oxygen as well as weather conditions and ocean currents. • Automated systems should be used if they~~that~~ improve feeding efficiency and reduce waste ~~should be used and~~ but for some species (e.g. trout) knowledgeable handfeeding ~~should be avoided~~is preferable • If possible, automated feeding systems should be equipped with underwater video technology if this improves feeding efficiency, enabling observation of feed pellet and fish feeding behaviour; methods for detecting uneaten feed, such as infrared and doppler sensors, should also be used; video technology and sensors should be used for deciding when to stop feeding • Integrated feeding and monitoring systems can enhance the efficiency of feeding regimes but are still under development; once they are suitable for an application at commercial scales they should be used	currents are important tools for determining daily feed quantity. Stable feeding every day. The trout habit of regular meals is important. I have a lot of respect for the manager on the farms who are experienced in feeding throughout the season. No automatic feeding system is seen to be on par with this ability to optimize feeding. Technology is used to handle volume at a level that helps the manager.	
Issues that have not yet been addressed in this document include: certification, ~~permitting regulations,~~ monitoring requirements (lead Estonia) and BAT/BEP to prevent the pollution of hazardous substances, BAT/BEP for biodiversity impacts (alien species and escapees) and litter and reporting requirements for recommendation 37/7.		