Baltic Marine Environment Protection Commission

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Background

Improving the aggregation rules of the assessment tool to be more ecologically coherent has been listed as one of the topics needing improvement towards an optimal assessment in the workplan for future work on HELCOM Eutrophication Indicators.

IN EUTROPHICATION 15-2019 discussed the topic 'Improving the aggregation rules of the assessment tool, to be more ecologically coherent', and took note that Aarhus University, Denmark, is willing to prepare the topic for the physical meeting of the group.

This document contains suggestions from Denmark on changes in the aggregation of the indicators in the assessment procedure.

Action requested

The meeting is invited to take note and consider the suggested changes in aggregation of indicators.

Aggregation of indicators

Aim: We suggest two or three changes in the aggregation of indicator in the assessment procedure. The purpose is to get correspondence between pressure and indicators for nutrients and bring the indicators for 'direct' and 'indirect' effects in agreement with the scientific basis.

Nutrient concentrations: Presently, the criteria group 'Nutrient levels' consist of four indicators: DIN, TN, DIP and TP. The consequence is a lack of a clear relationship between the pressures – inputs of nutrients - and the indicator. E.g. will an increase in nitrogen concentrations and a decrease in phosphorus concentrations, or *vice versa*, mean no change in the criteria group 'Nutrient levels'. Likewise will changes in the natural conditions, as the recent increase in phosphorus concentration in the eastern Baltic due to inflow of saline bottom water, mask a possible decrease in nitrogen concentrations when aggregated into the criteria group.

In general, the optimal situation is to have a clear relationship between a pressure variable and each indicator, when possible.

The proposed change is to split the criteria group 'Nutrient levels' into two; 1) nitrogen (winter DIN, TN) and 2) phosphorus (winter DIP and TP).

The advantages is that 1) we get at clear relationship between the indicators and the pressures (inputs) or biogeochemical processes affecting nitrogen or phosphorous. Moreover, one of the indicators can be omitted for a basin, if the nutrient is considered less important for eutrophication in that basin. E.g. for Kattegat, where nitrogen is usually the limiting nutrient.

The consequence is one additional criteria group and hence one more group that can cause a basin to fail in the final OOAO test.

Direct effects: The current practice is to aggregate chlorophyll, water clarity (light attenuation), and Cyanobacteria into one criteria group called 'Direct effects'. The reasoning behind is probably that chlorophyll was considered to be the factor causing light attenuation. However, the reality is that in coastal water bodies, light attenuation is dominated by organic matter, often mainly colored dissolved organic matter (CDOM) but also organic particles (POC). Chlorophyll is, in general, only responsible for 5 to 15 percent of the light attenuation. Only for clear oceanic condition is phytoplankton pigment dominating the variability in diffuse PAR light attenuation (water itself is dominating the absolute attenuation under oceanic conditions, but is not causing any variability).

Based on this we suggest to moved 'light attenuation' from the criteria group 'direct effects' to the criteria group 'indirect effects' of eutrophication.

The other indicators in 'indirect effects' are currently oxygen deficiency and the state of the soft-bottom macrofauna community.

The oxygen deficiency is clearly related to the input of organic matter to the bottom water/sea floor and hence the amount of organic matter in the system, i.e. the same basic characteristic as light attenuation.

After the suggested change, the criteria group 'Direct effects' include 'chlorophyll concentration' and 'Cyanobacterial bloom index'. Both are indicators that describe the response of the phytoplankton community to eutrophication.

Indirect effects: After the suggested change, the criteria group 'Indirect effects' include oxygen deficiency, light attenuation, and soft-bottom macrofauna community (see more about the latter below). Both oxygen and light attenuation are indicators that relate to the amount of organic matter in the system including both dissolved and particulate forms. Oxygen deficiency also relate to the organic matter in the sediment. Thus, the criteria group 'Indirect effects' has a sound scientific basis.

Currently, the indicator 'State of the soft-bottom macrofauna community' is in the criteria group 'Indirect effects'. However, it is unclear, and probably variable among basins, how the macrofauna respond to eutrophication. Moreover, it clearly respond to other press factors like bottom trawling. An additional suggestion for a change, therefore, could be to propose a new criteria group called 'Ecosystem functioning'.

Ecosystem functioning: Eutrophication clearly affect the functioning of marine ecosystems, food webs and biodiversity in a number of ways. Three obvious effects are 1) deterioration of macrophytes communities due to shading, 2) decrease in macrofauna biodiversity and 3) a change in the depth location of phytoplankton biomass and production from in/or below the pycnocline to the surface due to increasing light attenuation. All three changes have clear implications for the higher trophic levels and together describe the overall ecological effects of eutrophication. Other changes in the food webs are known, e.g. an increase in populations of benthic filtrators, like blue mussels, and their predators, e.g. eider ducks. However, the exact nature of some of these changes vary between basins. Therefore, a suggestion is to include a 'ecosystem functioning' criteria group based on three indicators; macrophytes, state of benthic macrofauna and presence of a productive phytoplankton community in the pycnocline.

Overview after suggested changes