Task 4.2.5 Propose how the thresholds can be applied for the development of environmental targets affecting seabed habitats

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1. Introduction

HELCOM is developing a Second Holistic Assessment of the Ecosystem Health of the Baltic Sea through the HOLAS II project that started in late 2014 and will run until mid-2018. The 2nd holistic assessment will assess progress towards reaching a Baltic Sea in a Good Environmental Status and will follow-up the initial HELCOM holistic assessment that was published in 2010 (HELCOM 2010). The Contracting Parties to the Helsinki Convention being EU Member States have decided to use the outcome of HOLAS II for the purpose of their reporting under Article 8 of the Marine Strategy Framework Directive (MSFD) in 2018.

Currently, several projects and activities are being conducted to deliver the first version of the 2nd holistic assessment by mid-2017 (HELCOM 2017) which will serve national MSFD consultation purposes. An updated version of the assessment report, including the most recent monitoring data and taking into account the outcome of the consultation process, will be prepared by mid-2018. The SPICE project contributes to the finalization of the holistic assessment, including development and refinement of central components of the report that are also requirements under the MSFD.

The state of marine benthic and pelagic habitats is threatened by several land-based and sea-based human activities. The HELCOM Baltic Sea Pressure Index and Impact Index (BSPII) are methods which can be used to estimate human activities and the cumulative pressures and impacts on marine environment and they have been further developed to fit to the purpose of the HELCOM 2nd Holistic Assessment through the HELCOM TAPAS project. While the existing tool can present spatially resolved maps of activities, cumulative pressures and impacts, it does not have validated linkages to the state of the benthic and pelagic habitats and hence it does not allow estimates of GES. In the Theme 4 of the SPICE project, guidelines are produced for an assessment of benthic and pelagic habitats, possible thresholds will be tested and draft assessments will be produced.

This report presents the findings of the task 4.2.4 “Propose how the thresholds can be applied for the development of environmental targets affecting seabed habitats”. The EU MSFD defines environmental targets in relation to pressures or directly to human activities and they allow also links to management measures. The adverse effects assessed in this WP4 were analyzed in relation to setting environmental targets under the MSFD.

2. Environmental targets in relation to marine habitats

Environmental targets are developed in relation to pressures or directly to human activities and they allow also links to management measures. In this task, we have summarized the most tangible thresholds for assessment of seabed habitats and proposed how they could be turned into environmental targets. Based on the work done in the BalticBOOST project, we also discuss what approaches could be used to develop environmental targets under the EU MSFD. The focus of this report is in the environmental targets for the benthic and pelagic habitats.

Applying thresholds to the development of environmental targets (as defined in Art. 10 of the MSFD) is not a simple task. The following challenges were identified:

- Anthropogenic pressures affect habitats through several mechanisms and differently in different habitats. In the benthic habitats, for example, maintenance dredging of a fair lane causes loss of the habitat in the dredging area, it causes heavy sedimentation on seabed adjacent to the dredging area, it causes turbidity in the water column, resuspension of nutrients and hazardous substances and also continuous noise (and impulsive noise if explosives are used on rocky areas). These affect the adjacent habitats in different ways, but the effect is always dependent on wind conditions, local currents (surface and bottom currents), local sensitive species, the season (i.e. whether there are sensitive features or functions present at that time) and other factors which may be even unknown. Thus, plenty of information to be considered before any conclusion of the adverse effect can be achieved and environmental targets set up to avoid these effects.

- The thresholds for adverse effects can be used as defining GES of a habitat but they are not directly applicable as environmental targets. For instance, an adverse effect of sedimentation on perennial macroalgae was defined in the SPICE task 4.2.1 (see the respective SPICE deliverable) as 3 mm of loose sediment on a hard substrate. In order to interpret this as an environmental target, one would need to relate this into amount of human activity. The BalticBOOST project showed that even a small dredging activity increases the water-column turbidity and sedimentation to seabed above potential thresholds (see Korpinen et al. 2017a). Thus, the environmental target cannot be defined as the amount of activity, but perhaps as the timing of the activity (i.e. to avoid sensitive period in local habitats), locality of the activity (i.e. to avoid sensitive habitats) or spatial extent of similar activities/pressures.
- Environmental targets may be difficult to match with GES definitions (see discussion on that in the BalticBOOST WP 3.1 deliverable 2; Korpinen et al. 2017b). In case of the state of habitats, GES is defined as a specific proportion of the habitat area being in good state (European Commission 2017). The rest can be adversely affected. This means that an environmental target requires at least three types of thresholds to be defined: (1) threshold for a pressure/activity causing adverse effect, (2) threshold for the extent of the adverse effect from the source of the pressure, and (3) threshold for the allowed proportion of the habitat being adversely affected. As the GES is affected by several pressures and all of them may require the specific three thresholds, an environmental target can likely not be as broad, but more reasonably, a specific target for an activity or pressure which may reflect one or more of the three thresholds.

In this report the habitat-related environmental targets are developed in the context of the above considerations.

3. Evidence for thresholds from SPICE and BalticBOOST projects

The SPICE task 4.2.1 results – together with other results from BalticBOOST (Korpinen et al. 2017a) – showed that it is possible to define thresholds for pressure intensity or effect distances. Such thresholds reflect, in general manner, adverse effects which are seen in benthic and pelagic habitats.

The SPICE task 4.2.1 analyses revealed that in the areas where bottom-trawling is not practiced, the major pressure to benthic habitats is eutrophication (including riverine loads, local nutrient concentrations, direct effects (such as decreased water transparency and planktonic blooms) and hypoxia. Thresholds were listed for nutrient concentrations, hypoxia, hydrogen sulphide concentrations, water transparency and chlorophyll a concentrations. This may be the situation in at least half of the Baltic Sea seabed area. Thus, the environmental targets should include eutrophication-related indicators. In the southern Baltic Sea, the bottom-trawling fishery is practiced widely and is likely at least as wide and intense as the eutrophication effects. This situation is described in more detail in the HELCOM's State of the Baltic marine environment report (HELCOM 2017).

The role of non-fishery **physical pressures** can still be significant in the smaller scale, but the evidence for these is scarcer. Such an evidence was found in SPICE Theme 4 for habitats which typically occur in sheltered bays (e.g. charophyte habitats), where increased turbidity or water circulation cause not only adverse effects to the species composition but may also lead to the loss of the habitat extent. The effect of physical pressures may be weaker in more exposed sea areas, as found in the BalticBOOST project, but this is a broad generalization, as sand extraction pits in exposed seabeds have been found to last almost unchanged for over 7 years in the open coast of the Gulf of Finland (J. Virtasalo, Finnish Geological Survey).

The SPICE report also analyzed possible distance thresholds which could be used to define the extent of adverse effects. Such evidence is mandatory in order to make spatial assessments of the adversely affected habitat area.

No scientific evidence, however, was suggested for the proportion of habitats allowed to be adversely affected.

The SPICE task 4.2.1 report found also clear evidence for thresholds in pelagic habitats. The report concluded that a change in habitat condition for its characteristic species is a major driver and therefore the physical and chemical parameters affecting the species composition can be used for thresholds. The HELCOM eutrophication indicators for offshore and coastal waters have thresholds defined for different local conditions and these are defendable choices as thresholds for adverse effects in pelagic habitats.

From the available evidence it is especially clear that the effects of physical pressures are not well understood in the marine environment. The effects of bottom trawling are perhaps the best known and modelled effects, but the methods applied in that assessment are not applicable to other physical pressures. The challenge of these more point-like pressures is in defining spatial effect distances and temporal lasting and the great variability in different environmental conditions. More targeted research is needed to estimate their relationships with the adverse effects.

4. Possibilities to apply the habitat thresholds as environmental targets

Adverse effects are typically habitat specific. For example, the isolated lagoon biotope is characterized by dense macrophyte vegetation (usually charophytes) and its natural nitrogen concentration and turbidity are very high. Opposite is true for the nitrogen concentration and turbidity in rocky macroalgae habitats. Hence, using the HELCOM nitrogen thresholds for these both habitats to define adverse effects would cause erroneous results.

Another example is the more detailed biotopes which are defined on the basis of characterizing species (HUB 6). As shown in the SPICE task 4.2.1, benthic fauna have a very broad range of hypoxia tolerance which means that different HUB 6 biotopes have different sensitivities to hypoxia. Similarly benthic plant species respond differently to nutrients, hypoxia, turbidity and wave exposure.

The SPICE Theme 4 proposed to define thresholds for adverse effects in as detailed level of biotope classification as necessary, even if from the management point of view a broader biotope classification could be more applicable. However, the detailed approach has strong arguments, as found out in the BalticBOOST project (Korpinen et al. 2017 a). In a case study from the Mecklenburk Bight, it was noticed that sand and gravel extraction was covering only a minor proportion of the sandy seabed (defined as the broad habitat level; EUNIS 2 or 3), but when comparing it with the biologically relevant biotope classification (i.e. the EUNIS 6 class), the exploitation was targeting to a specific grain size of the sandy seabed which was considered as a specific HUB 6 biotope type in the area. Thus, that biotope type is under very high pressure and the state of the biotope is very likely poor.

As pointed out in Chapter 2 above and also shown in the previous example, we argue that the environmental targets also need to be defined on detailed biotope level. For instance, developing an environmental target for an eelgrass meadow needs to consider eelgrass specific threshold for adverse effects, and a respective amount of pressure needs to be reduced (or an activity forbidden within a certain range). This does not mean that this pressure reduction would not positively affect other biotopes as well, but the positive effect might be weaker.

As the thresholds for adverse effects on biotopes are often derived from pressure-state comparisons, they provide a possibility to develop environmental targets. Such thresholds are, e.g., the nutrient concentrations, turbidity, sedimentation or altered water circulation.

The thresholds derived from indirect effects (e.g. hypoxia) are, however, not directly linked to pressures, but one should consider the environmental target by other means.

5. Distance thresholds to allow spatial analyses

The distance thresholds developed in the SPICE task 4.2.1 allow for spatial analyses of adversely affected seabed area. Due to the lack of resources, SPICE couldn't develop these specifically to different habitats, but it was generally noted that the substrate type gives a general indication of the sensitivity to physical pressures and, thus, some habitat-specific effect analyses can still be made. Based on these analyses, it is possible to evaluate the extent of anthropogenic pressures and adverse effects.

The distance thresholds can be used together with the thresholds for adverse effects for setting the environmental target. For instance, a turbidity of 8 NTU (or 7 mg/L suspended solids) was proposed as a general threshold for 'Baltic photic muddy sediment characterized by macroscopic infaunal biotic structures' (HUB class AA.H3) and a distance threshold of 0.6 km was proposed (SPICE task 4.2.1; Perus et al. 2007). With this information one can estimate the adversely affected area. If the area hosts also a sheltered bay with the biotope 'Baltic photic muddy sediment characterized by submerged rooted plants' (HUB class AA.H1B), the turbidity and suspended solids thresholds are much stricter (2.5 NTU and 2-3 mg/l) and the environmental target should be developed from this biotope point of view.

The SPICE Theme 4 did not have a science-based solution to the question, how large proportion of a biotope is allowed to be adversely affected, but the following aspects could be considered:

- It may not be appropriate to use a flat rate for all biotopes. For instance, a rare habitat (i.e. small extent in the region) may lose its functions even if a small area is lost or adversely affected. Similarly, a threatened habitat may require all its extent to recover and support its communities and functions.

- The thresholds for adverse effects may differ in marginal areas of habitat extent, where the environmental conditions give extra burden to the existence. A common example is the salinity tolerance in the Baltic Sea. The threshold may need to be lower in such areas.
- The threshold for the proportion of biotope in GES may require consideration of ecological coherence. This means that adversely affected areas should not be all in a single area, because a wide gap in biotope distribution may cause even wider consequences for the ecological functions of that habitat (e.g. in terms of connectivity). Therefore one could set some rules to where the adversely affected habitat areas are allowed to be located. This could embedded within the environmental target.

References

European Commission (2017) Commission Decision (EU) 2017/848 of 17 May 2017 laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardised methods for monitoring and assessment, and repealing Decision 2010/477/EU. Off. J. Eur. Union L 125/43.

HELCOM (2010) Ecosystem health of the Baltic Sea 2003–2007. HELCOM initial holistic assessment. Baltic Sea Environment Proceedings 122. Available at www.helcom.fi

HELCOM (2017) First version of the ‘State of the Baltic Sea’ report – June 2017 – to be updated in 2018. Available at: http://stateofthebalticsea.helcom.fi

Korpinen S, Zweifel UL, Bastardie F, van Denderen D, Hoppe K, Jonsson P, Kauppila P, Milardi M , Nielsen R, Nilsson H, Norén K, Nygård H, Sköld M, Valanko S, Zettler M (2017a) Estimating physical disturbance on seabed. Deliverable 1 of the BalticBOOST project Theme 3.

Korpinen S, Zweifel UL, Bastardie F, van Denderen D, Hoppe K, Jonsson P, Kauppila P, Milardi M , Nielsen R, Nilsson H, Norén K, Nygård H, Sköld M, Valanko S, Zettler M (2017b) Guidelines for setting environmental targets for benthic habitats. Deliverable 2 of the BalticBOOST project Theme 3.