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Background

Following decisions of the HELCOM EN-Noise online meeting held on 17 April 2020 to prepare and submit to TG-Noise, in advance of the upcoming TG-Noise meeting 2 June 2020, a document presenting the views and approaches of the network on assessment of GES in the Baltic and get reactions from EU TG-Noise, a draft document was prepared by the Chair of the network and shared with the network for input by 18 May 2020. At that point the document addresses only continuous noise, pending on the discussions on impulsive noise. Such discussion took place on the online meeting of the network held on 18 May 2020. As a result of such discussion the draft document has been revised by the Chair of the network to incorporate input on the impulsive noise section. No additional input on such section has been provided, thus the document was submitted to EU TG-Noise for consideration.

This document contains the document by HELCOM EN-Noise submitted to EU TG Noise for consideration.

Action

The Joint Session is invited to take note of the information and make use of it when discussing GES threshold values both for continuous and impulsive noise.

HELCOM EN-Noise Considerations on the assessment of GES with respect to underwater noise

Background

The EU Marine Strategy Framework Directive (MSFD) requires EU-member states to assess anthropogenic underwater noise and establish Good Environmental Status (GES) in marine waters. The Commission Decision (EU) 2017/848 states that "Member States shall establish threshold values for these levels through cooperation at Union level, taking into account regional or subregional specificities". This document describes the approach currently under discussion in the HELCOM underwater noise expert network (EN-Noise), applicable to the Baltic Regional Sea. It is submitted to EU TG-Noise with a request for feedback.

The two different criteria in the EU MSFD for underwater noise (D11C1 and D11C2) are treated separately below.

Notes on terminology

The term **noise** is used to indicate a sound, which is unwanted (detrimental) from the perspective of the wellbeing of the marine ecosystem, i.e. a sound that, one way, or the other (including through injury), makes it more difficult for animals to carry out their normal behaviour.

The term **threshold** is used to describe a level, which, if crossed, elicits some action. Exceeding the thresholds for GES discussed below should thus elicit actions to reduce the overall emission and/or impact of anthropogenic noise. Such thresholds for GES are different from **emission limits**, which are management actions taken to reach GES and are the levels that individual noise producers (ships, construction activities etc.) should adhere to.

D11C1 (impulsive noise)

EN-Noise interprets this descriptor as being primarily about disturbance and habitat exclusion due to impulsive noise, but also considers the possibility of injury caused by exposure to loud, impulsive sounds. Thresholds for GES were discussed on the BalticBoost workshop in Copenhagen 5-6 October 2016 (HELCOM, 2016), previously reported to EU TG-Noise. The workshop agreed on the following guiding principles for setting GES thresholds for marine mammals:

1. Individuals should not be exposed to anthropogenic noise levels high enough to induce permanent hearing loss.
2. Significant loss of habitat through displacement for a significant period of time that is likely to affect population should be avoided.
3. Noise level should not affect the energy budget of individual animals nor breeding to a degree likely to affect the population significantly; particular emphasis should be on calving and nursing grounds.

And the following principle for assessing GES for fish:

4. Noise levels high enough to induce significant behavioural disruption at a population level should be avoided in spawning areas at critical timing.

EN-Noise recognises the need for assessment procedures and thresholds to take into consideration differences between regions, species and populations of animals. This relates in particular to the following:

- Different conservation status of populations. Criteria and thresholds for GES should be stricter for geographical regions containing populations in unfavourable conservation status. This implies that the same activity conducted in two different areas could be assessed differently, depending on differences in vulnerability of the populations. A particular relevant example is the difference in

conservation status of the harbour porpoises in the Baltic proper (critically endangered) and in the Danish Straits (stable population).

- Application of measures known to reduce impact should be reflected in the assessment of GES. In particular, if mitigation measures (such as noise abatement technologies) are applied to a noise source, this should be reflected in a reduction of the assessed pressure and impact, compared to an assessment of the unmitigated activity.
- Differences in sound propagating conditions between regions should be reflected in the assessment. This in particular relates to the lower salinity in the Baltic, leading to a lower absorption coefficient, which again may lead to larger ranges of disturbance for the same sound sources.

EN-Noise would kindly invite discussions and proposals on these issues, addressing how assessment procedures and thresholds for GES can be adapted to reflect regional differences.

D11C2 (continuous low frequency noise)

Interpretation of the descriptor and the criterion

EN-Noise interprets this descriptor as targeting primarily the detrimental effect of a chronic increase in the ambient noise. An increased ambient noise level can affect marine organisms in several ways, but currently the impact through masking of the perception of other sounds appears to be the only mechanism for which robust predictions can be made. Other effects, such as elevated stress hormone levels and cardiovascular responses in exposed animals are not dismissed as unimportant, but are at present not sufficiently well studied to serve as basis for defining and managing GES. The monitoring and assessment of D11C2 is therefore based on assessment of masking potential of anthropogenic noise.

Masking and communication range reduction

Masking is intrinsically linked to the signal-to-noise ratio (SNR). SNR expresses the ratio between the magnitudes of the signal of interest and the ambient noise (natural plus anthropogenic), both quantified in appropriate units. Ultimately, the SNR sets the limit to the maximum communication distance between sender and receiver. If the ambient noise is increased (through natural processes, or anthropogenic activities), the maximum distance over which communication can take place will go down.

Animals are naturally adapted to handle the fluctuating levels of noise in their surroundings and their communication is likely to be limited by ambient noise most of the time. Relevant metrics for assessing potential impact of anthropogenic noise is therefore related to how much and how often the ambient noise is dominated by anthropogenic sources. This **dominance** is proposed to be evaluated by assessing the difference between the natural ambient noise level and the total noise level (termed the **excess level**) and tallying how often this excess level exceeds some pre-determined cut-off level. The **dominance** in a given position and evaluated through actual measurements or by modelling, is expressed as a percentage of the assessment period, where the noise is dominated by anthropogenic sources. To avoid overestimating the impact of distant ships on very quiet days, it may be useful to introduce a minimum level for the ship noise.

If the dominance is estimated through spatiotemporal modelling, the contribution of anthropogenic noise to the area can be assessed through construction of an exposure function Merchant (Merchant et al., 2018). This exposure function expresses the relationship between dominance and area, i.e. quantifies how often and in what fraction of the area ship noise dominates over natural ambient, in a way conceptually similar to the assessment proposed for impulsive noise (Merchant et al., 2018).

The exposure function described above quantifies the pressure on the marine environment from anthropogenic noise, not the impact. In line with the impulsive noise risk indicator (Merchant et al., 2018), the dominance can be combined with animal distribution data (either in the form of density surfaces or habitat ranges). By this combination, a risk surface is obtained, where high values indicate coincidence of high dominance of anthropogenic noise and high animal abundance, which indicates an elevated risk of

impact. The exposure function can again be used to evaluate this risk surface for a larger area. By such an evaluation, the relationship between how often and how large fraction of a population/critical habitat is dominated by anthropogenic noise, can be expressed and evaluated.

Open issues for discussion

The approach outlined above appears well suited to assess GES, for a number of reasons, of which the most important ones are:

- The reference condition is the natural ambient noise level at the location under assessment. It is not a guesstimated historical mean, averaged across a wide geographical area, or an arbitrary baseline level from the start of monitoring programs, but a second-to-second, local estimate of what the ambient noise would have been, had there not been any anthropogenic sources.
- This continuously updated reference condition automatically incorporates changes to the natural ambient noise level, irrespective of what causes these changes (natural, long-term fluctuations or related to climate change).
- The excess level is closely linked to the ability of animals to communicate. The larger the excess level, the more difficult conditions for acoustic communication, i.e. the higher the anthropogenic pressure on the ecosystem.
- Any assessment of GES must, to be evidence based, be founded in some measure of impact on the marine ecosystem. Currently, however, there are, to the best of our knowledge, no methods available to estimate directly the impact from continuous underwater noise on animal populations or habitats. In the absence of such methods, the risk-based approach offers a method, which can incorporate empirical information about the sensitivity of different species. If GES is managed entirely through a pressure-based criterion, there is no method by which such empirical information can enter into the process, which leads to thresholds for GES.
- Adding animal distribution or habitat information to the assessment allows a more targeted evaluation, where it is possible to evaluate the effects that changes to the temporal and spatial distribution of noise sources have on the impact on animals. This allows further improvement of conditions to be obtained by changing spatiotemporal distribution of sources, in situations where it is impossible or prohibitively expensive to further reduce the number of sources or the level of their emissions.

However, before actual indicators and criteria for GES can be established by the method outlined above, a number of critical issues must be addressed, and decisions taken. The fundamental issues, on which we seek for EU TG-Noise views, are the following:

- *Dealing with frequency*. In order for masking to take place, there must be an overlap in frequency between the masking noise and the masked signal. Currently, the EU MSFD assessment is based only on the third-octave bands around 63 Hz and 125 Hz, with an option to include other bands. The EN-Noise propose an open discussion of this issue and suggest considering additional frequency bands of both higher frequency and higher bandwidth, in order to cover species, which communicate at higher frequencies.
- *Cut-off value for excess level*. The suggested approach relies on defining a cut-off value for the excess. If the excess level is above this cut-off value, ship noise is considered to dominate. By definition, excess is non-negative (the excess is 0 dB in the total absence of ship noise), so the cut-off value must be a positive value. The EN-Noise proposes 20 dB as the cut-off level and invites views on this choice. A decrease in SNR of 20 dB constitutes a significant deterioration of conditions for communication and choosing a lower value is likely to introduce more uncertainty in assessments through uncertainty in the soundscape modelling.
- *Threshold values for GES*. The extreme endpoints of the exposure curves are well-defined from a GES perspective. If ship noise never dominates the soundscape anywhere in the assessment area, we

must have GES, because conditions are at reference conditions. Alternatively, if ship noise dominates all the time, everywhere, GES is most certainly compromised. The threshold is somewhere between these two extremes, but an evidence-based approach to defining the actual threshold value is still missing. The EN-Noise would kindly invite proposals for and discussion of such methods to define and derive threshold values.

- *Combining assessments for multiple species/habitats*. The approach outlined allows for simultaneous assessment of several indicator species and/or critical habitats. If this is accomplished, this immediately raises the question of how GES assessments can be combined. Should each species/habitat be evaluated individually and held against species/habitat specific thresholds for GES? If so, how are these assessments to be combined? Through a weighted average, or a precautionary one out – all out fashion? Alternatively, is it possible to combine species/habitat specific thresholds for GES into one regional threshold for GES? The EN-Noise would kindly invite for input and discussion on these issues.

References

HELCOM. 2016. Outcome of the HELCOM BalticBOOST Workshop on Underwater Noise.
Merchant, N.D., R.C. Faulkner, and R. Martinez. 2018. Marine noise budgets in practice. *Cons. Lett.* 11:1-8.