Document title	Proposal for further work on SOM analysis for underwater noise
Code	2-3
Category	DEC
Agenda Item	2 – SOM analysis for underwater noise
Submission date	17.6.2019
Submitted by	Denmark
Reference	

Background

HOD 55-2018 agreed to establish an ad hoc platform for analysing sufficiency of measures (SOM Platform) to support the update of the Baltic Sea Action Plan (Outcome HOD 55-2018). The aim of the SOM analyses is to evaluate whether existing policies are sufficient to achieve good environmental status (GES) in the Baltic Sea. To contribute with the required data and information for the analyses, topic teams will be established for each of the topics addressed by the SOM Platform. The topic teams will work intersessionally and report back to SOM Platform meetings and relevant Working Groups during the course of work. One of the topic teams focusses on underwater noise.

PRESSURE 10-2019 took note of the initial plan for the SOM analyses on underwater noise (document DS-12), noting that EN Noise will be engaged in the work (Outcome of PRESSURE 10-2019, para. DS10).

This document contains proposals on how to further continue the work on SOM analysis for underwater noise.

Action requested

The Meeting is invited to discuss and agree on:

- geographical scales for (i) activity-pressure and (ii) measure-pressure for the SOM analysis on underwater noise;
- aggregation of the list of activities/sources generating underwater noise into a smaller number of groups so that SOM-modelling is feasible;
- a common understanding of how the input from activities and effect of measures should be quantified in the SOM analysis; and
- a procedure for assessment of contributions from activities and effectiveness of measures.

Proposal for further work on SOM analysis for underwater noise

Geographical scales for (i) activity-pressure and (ii) measure-pressure for the SOM analysis on underwater noise

The EN-Noise took note that the geographical scale is to be considered for two different purposes: (i) activity-pressure (simpler; it should reflect the activity levels in the sub-basin groupings); and (ii) measure-pressure (more complex; it should reflect the governance and activity levels in the sub-basin groupings). There is no need for both scales to be identical. There is the possibility to group those sub-basins in the scale 2 of the HELCOM Monitoring and Assessment Strategy (see attachment 4 of the Strategy). The EN-Noise discussed the possibility of having a similar subdivision and agreed on the need to have a maximum of six subdivisions for technical reasons linked to the model used for the SOM analysis. The EN-Noise agreed to have the same scale for the two purposes discussed (Memo of the on-line meeting 21 May 2019).

It is proposed to divide the Baltic Sea in the following areas:

- Gulf of Bothnia (Bothnian Sea, the Quark and Bothnian Bay; inclusion of Åland Sea and Archipelago Sea to be discussed). Justification: hydrographically well separated from the central Baltic, with low levels of shipping and extensive ice coverage in winter. Also core habitat for the Bothnian subpopulation of ringed seals, which is considered healthier than the subpopulations in the Gulf of Finland/Gulf of Riga.
- Gulf of Finland, possibly also Gulf of Riga, Åland Sea and Archipelago Sea (to be discussed). Justification: Like the Gulf of Bothnia, these waters are shallower waters and thus separated from the deeper central Baltic. Also, these waters, together with Gulf of Bothnia, constitute the main habitat for ringed seals.
- Central Baltic (N+S Baltic Proper, E+W Gotland Basin, Gulf of Gdansk). Justification: Hydrographically well-defined and dominated by deep, partly anoxic waters.
- Western Baltic (Danish Straits and Kattegat). Justification: shallow waters and narrow straits with heavy shipping. Hydrographically well separated from the Central Baltic by the southern shallows of the Sound and the Darss sill.

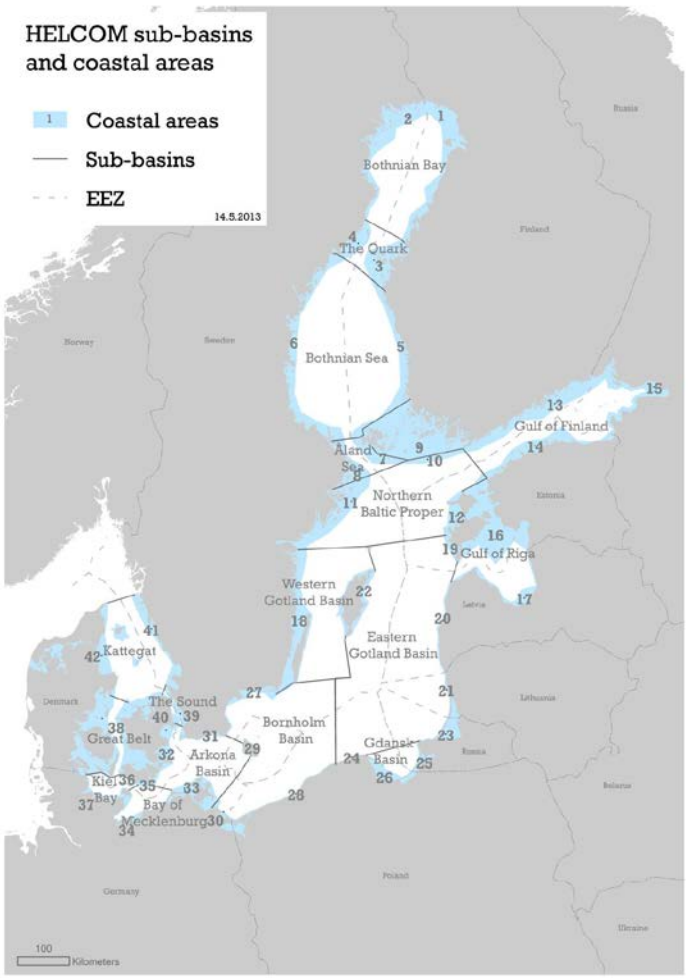

Figure 1. Map of the Baltic Sea presenting the HELCOM sub-division into 17 open sub-basins and 42 coastal areas. The names of the open sea areas and coastal areas are provided in Tables 1 and 2, respectively in Attachment 4 of the HELCOM Monitoring and Assessment Strategy. EEZs of the countries are shown with a grey dashed line.

Aggregation of activities/sources generating underwater noise

In the end of this document is a list of anthropogenic sources of sound, which has been drafted by Denmark with input from Germany and Poland when shared for commenting to the EN-Noise (e-mail sent on 10 May 2019). They are not listed in any kind of priority according to energy output or expected impact on the environment. The list is intended to be as complete as possible, which means that some of the sources may be of limited relevance to the HELCOM region at present. The sources are divided into three categories. This has been done to align the sources with HELCOM guidelines for monitoring etc. and does not reflect any fundamental differences in the physical properties of the sources or their potential for affecting the marine environment. The groups are continuous low-frequency sources (which may or may not have considerable energy also at higher frequencies), impulsive sources below 10 kHz (which also in addition may or may not have considerable energy above 10 kHz) and other sources. The first two categories are each covered by their own pre-Core indicator, whereas the third category contains sources currently not covered by any HELCOM indicator.

This list is to be considered as a living document during the whole SOM process. There is a need to group the list of anthropogenic sources of underwater noise/sound so that they account for a significant effect (Memo of the on-line meeting 21 May 2019).

Below is a proposal for aggregation of sound sources into a lower number of groups, to simplify assessment and modelling in the SOM-Platform. Lettering is for identification only and does not represent a ranking in order of importance or anything else).

A. Ships required to carry AIS-transmitters.
B. Smaller boats not required to carry AIS-transmitters.
C. Construction, dredging, towing of fishing gear etc.
D. Stationary infrastructure (bridges, tunnels, platforms, offshore wind farms, pipelines etc.).
E. Impulsive sources with peak energy below 10 kHz (pile driving, seismic surveys, certain military sonars, explosions, etc.).
F. Impulsive sources with peak energy above 10 kHz (echosounders, sonars, subbottom profilers, pingers, seal scarers etc.).

Quantification of the input from activities and effect of measures in the SOM analysis

The EN-Noise discussed how to estimate the contribution (in percentage) of each activity to the noise and agreed to continue the discussion on how to quantify these percentages in the physical meeting of the network in June. The meeting was of the view that the contribution (in percentage) of the different activities to generate the noise pressure should be used as a contribution to the definition of new measures to tackle it. The meeting supported the proposal to start using the current indicators (63/125 Hz band, 2000 Hz band and impulsive noise indicator) for the definition of measures (Memo of the on-line meeting 21 May 2019).

Some challenges are present, when assessing the relative importance/contribution of the various sources, which leads to important points for discussion by the network:

- The existing pre-core indicator for continuous noise covers sources A-D, but current modelling of their contributions is limited to group A and to a limited degree group B (smaller vessels that voluntarily carry AIS-transmitters). How can the remaining part of B, plus C-D, be included in the assessment?
- The existing pre-core indicator for impulsive noise is intended to cover all of group E, but in previous reporting years it is acknowledged that there is a substantial underreporting of activities, which means that the indicator is insufficient to assess the relative contribution of these sources.
- The last group, F, is not covered by any existing indicator and as it consists of a multitude of sources, some of which are very abundant (echosounders), it is an open question how this group of sources can be assessed.

Procedure for assessment of activities and measures

In the initial plan for the underwater noise part of the SOM-Platform (DS-12) it was stressed that the knowledge available about individual sources and their effects on the marine ecosystem is insufficient to justify truly quantitative modelling of the contribution of the various sources and the efficacy of existing and proposed measures for reduction of noise emissions. On the positive side, however, is that the sources are generally well known (cf. the list below) and the link between sources and state of the environment is direct (no lag-time in response, i.e. state essentially equal to pressure). It was therefore proposed in the initial plan (which has been adopted by Pressure-##) that the main output from the group's work is "...*expected to be a catalog of existing and suggested future measures to reduce underwater noise, including evaluation of their likely contribution towards achieving GES for the different species groups and, to the degree possible within the limits of allocated resources, include considerations of the cost of implementing the proposed measures*".

It is proposed that the network first attempts to quantify the relative contribution of the groups A-F to the pressure/state of the Baltic. It is proposed that this quantification is made with a resolution not higher than 1/10 (i.e. grading the relative importance in tens of percent of the total).

It could be discussed whether it is required to divide the assessment into a smaller number of receptor groups (such as seals, porpoises, demersal fish and pelagic fish).

In a similar fashion, the various existing and possible future measures can be assessed. Before such an assessment can be made, an exhaustive list of possible measures must be compiled by the network.

Complete list of sources, as of 10th of May 2019

Continuous low-frequency sources

Ship engines and propellers

Ubiquitous in the entire Baltic. Can be subdivided into larger ships, which predominantly occur in deeper waters and in connection to harbours, and smaller boats (leisure and smaller fishing vessels), which occur predominantly in coastal waters. The larger ships emit most energy at lower frequencies, whereas the noise from smaller boats emit their energy at higher frequencies. Thrusters also generate considerable noise at higher frequencies.

Ice breaking

Icebreakers emit broadband noise, with most energy at low frequencies.

Towed fishing gear

Towed gears are ubiquitous in the entire Baltic. Noise generation depends, among other factors, on the type and size of gear, in particular whether it is pelagic or in contact with the bottom (beam and otter trawls).

Offshore renewables (offshore wind turbines, wave energy converters, tidal turbines)

Limited occurrence at present. The limited information available indicate that the noise emitted is at low levels and low frequencies. Radiation depends on factors such as turbine size, foundation type and underwater dimensions.

Dredging and construction activities

Dredging, in connection to extraction of sand and gravel, maintenance of shipping channels or other offshore work on the sea bed, generate moderate levels of noise in the lower frequency range. Rock dredging can have different noise properties than sand/gravel extraction. Rock dumping (in connection with scour protection of wind farms) produces noise in the lower frequency range. A significant source of noise in connection to construction and maintenance activities are bow and azimuth thrusters used in dynamic positioning systems.

Offshore installations (platforms, pipelines etc.)

Offshore installations, such as platforms, with active machinery above or below the water line may emit substantial levels of noise into the water. Low frequency noise at low levels may be radiated from gas pipelines on the seabed, in particular close to compressor stations. Very limited information is available on this issue.

Bridges and tunnels

Restricted to coastal waters and particularly abundant in the Western Baltic. The limited information available indicate that the radiated noise is at very low frequencies and low levels.

Harbours (substrate borne sound from land-based activities)

Poorly studied and documented, but physics dictate that such noise will be at very low frequencies, due to the low-pass filtering properties of the substrate. Exceptions could exist for cases where noise is radiated directly into the water column through concrete walls or piers.

Aircraft noise

Limited to low frequencies and low levels immediately below aircrafts. Limited relevance to larger airports located directly on the coast and aircraft flying close above the water such as during military training and rescue or maintenance work from helicopters. Coupling of noise in air to water depends primarily on the angle to the surface and surface roughness.

Marine seismic vibrators

Marine seismic vibrators are currently being developed with the aim to replace airgun impulsive noise and coud be a sound source to deal with in the future. Existing vibrator technologies (Vibroseis) is currently not relevant in the Baltic Sea.

Impulsive sources below 10 kHz

Percussive pile driving

Several subdivisions are possible. Large diameter piles (several meters) are used offshore for wind turbine foundations, lighthouses etc. Smaller diameter piles may be used for jacket platforms, boat piers and conductor pipes for drilling in the sea bed. Sheet piles are used extensively in shallow waters for construction works and harbour piers etc.

Air-guns

Air-guns are used in large volume arrays for seismic surveys penetrating several kilometres into the crust of the earth, and in smaller scale for subbottom profiling in the topmost layers of the seabed. The noise is impulsive by nature at close range, but at larger distances (tens of km) multipath propagation of the signals will extend them in time and they eventually become a continuous addition to the ambient noise at low frequencies.

Explosions

Explosions, either in connection to construction works, military training, military operations or clearance of unexploded ordnance (UXO), can generate extremely high sound pressures (shock waves), which are potentially lethal and may induce hearing loss at considerable distances. UXO's occurs at varying densities throughout the Baltic, in some areas very high.

Sonars

A few sonars use signals below 10 kHz. These are primarily very powerful anti-submarine sonars and deep sea hydrographical sonars. Ships with such military sonars are abundant throughout the Baltic, but the use of the sonars is not well known. Hydrographical sonars below 10 kHz are likely uncommon in the Baltic.

Seal scarers

A few types of seal scarers use signals below 10 kHz, but it is unknown whether they are used in the Baltic.

Subbottom profilers (boomers, sparkers, chirpers and pingers)

This group contains a range of different, which emit powerful low-frequency signals to survey the uppermost layers of the seabed. They are used throughout the Baltic in connection to construction works, pipelines and cables and extraction of sand and gravel. Sound measurements are not available in the published literature for most of these devices.

Other sources not covered by above categories

Echosounders

Echosounders are ubiquitous throughout the Baltic. Larger ships tend to use lower frequencies, below 100 kHz, whereas smaller boats use higher frequencies. Some market-available echosounders cannot be turned off.

Sonars above 10 kHz

A range of different types is used for navigation, fish finding, multi-beam and side-scan surveys of the sea bed. Some are very powerful and in particular forward-looking sonars for navigation and advanced fish-finding have the potential to ensonify very large areas.

Pingers and seal scarers above 10 kHz

Several types of seal scarers and net pingers are used in different parts of the Baltic, in connection to fishing gear and aquaculture installations, but also as mitigation in connection to construction works. The occurrence of pingers and seal scarers in the Baltic is largely unknown.

Underwater telephone, control signals and underwater beacons and transponders

A number of instruments use loud signals in the range 20-80 kHz for communication with divers, between ships (navy only) and with different instruments and actuators on the sea bed. Acoustic beacons can be used for various purposes, such as references for dynamic positioning systems, controlling trawl net position, or as warning for submarines of underwater structures. They can emit pings regularly (beacons) or interactively (transponders).

Subbottom profilers above 10 kHz

Some types of subbottom profilers (pingers, chirpers) use powerful signals above 10 kHz, but are otherwise not different from the types included under the below 10 kHz category.

Monitoring and scientific instruments

A number of instruments, which actively use sound for measurements, are found. This includes Doppler logs, measurements of sound velocity, water current (ADCPs), suspended particles and other. Many of these instruments operate at very high frequencies (MHz). The sound level, frequency, direction of their use and acoustic aperture (radiation angle) determines the distance at which they can potentially be harmful to or disturb marine wildlife.