HELCOM SPICE Workshop on the pressure and impact assessment of HOLAS II using the Baltic Sea Impact Index (HELCOM SPICE BSII WS 1-2017)

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Background

The assessment of cumulative pressures and impacts in HOLAS II uses the Baltic Sea Impact Index, which has been developed under the HELCOM TAPAS project and guided by the previous workshops HELCOM Pressure index WS 1-2015, HELCOM TAPAS Pressure index WS 1-2016, and HELCOM TAPAS Pressure index WS 2-2106.

HELCOM HOD 51-2016 agreed in principle to use the method to calculate the Baltic Sea Impact Index (BSII) as developed by the TAPAS project, taking note that remaining issues on how to assess the impacts on ecosystem components will still be tested and that the final method to use in HOLAS II will be based recommendations from this workshop. This document describes the approach for assessment of cumulative impacts in HOLAS II using the Baltic Sea Impact index, based on the outcome of HOD 51-2016. Initial assessment results based on the presented approach will be given in document 3.

Actions

Participants are invited to

- familiarize with the content prior to the workshop and use it as background information when evaluating the results from the biodiversity assessment

Introduction

The Baltic Sea Pressure index (BSPI) and the Baltic Sea Impact index (BSII) are tools for spatial visualization and assessment of cumulative pressures and impacts in the Baltic Sea marine area.

The BSPI and BSII were first applied in the initial HELCOM holistic assessment of ecosystem health (HELCOM 2010a), building on concepts described by Halpern et al. (2008, 2015). The methods that were applied are described in HELCOM (2010b) and Korpinen et al. (2012). The concepts were subsequently developed further for the eastern parts of the North Sea by the HARMONY project (Andersen et al. 2013), which has developed a HARMONY Pressure & Impact Mapper software (Stock 2016). The same methodology has also been used in the Mediterranean and the Black Sea (Micheli et al. 2013).

In the first holistic assessment, the Baltic Sea Impact Index (BSII) was based on georeferenced data sets of human activities, pressures and ecosystem components, and on sensitivity estimates of ecosystem components (so-called sensitivity scores) that combine the pressure and ecosystem component layers. The scores estimate the potential impact of each assessed pressure on specific ecosystem components. The Baltic Sea Pressure Index (BSPI) assessed the anthropogenic pressures/human activities in the defined assessment units without including ecosystem components. It however included a weighting component in order to grade the effect of the pressures on the ecosystem in a generalized perspective.

For the second holistic assessment, the methods have been re-evaluated and developed further with respect to data preparation, index development, linking the impacts to pressures and human activities, developing the sensitivity scores, and visualization of the results, as described in this document.

Methods

Overview

The key components of the Baltic Sea Impact Index (BSII) are 1) spatial information on the distribution of key ecosystem components, 2) spatial information on the pressures to be considered, and 3) sensitivity scores to estimate the sensitivity of different ecosystem components to each of the pressures. The information on ecosystem components represents the spatial distribution of habitats and species and the information on pressures represents the levels of pressures at sea from anthropogenic activities in the region. The sensitivity scores are used to estimate the potential impacts of the pressures on each ecosystem component and they also include aspects of recoverability and tolerance. The Baltic Sea Pressure Index (BSPI) uses only the overlaid pressure layers.

In the initial holistic assessment (HOLAS I) the sensitivity scores were estimated by expert judgment (HELCOM 2010a,b). In the HOLAS II assessment, the sensitivity scores build on a more thorough expert survey and an increased emphasis is given to evidence from scientific literature. The sensitivities in relation to all pressures and ecosystem components were covered by the expert survey. In addition, sensitivities of benthic features were supported by a literature review (Korpinen et al. 2017) and literature information was used also for other ecosystem components where the experts-based scores showed low confidence (see more details below). The spatial data sets have been updated and redefined in alignment with a list of human activities and pressures of relevance for the Baltic Sea, as identified by the HOLAS II Core team (HOLAS II 5-2016, Document 4-3-Add1). Key ecosystem components were identified based on the outcomes of STATE & CONSERVATION meetings and HOLAS II 5-2016, and have been developed within the TAPAS Project, which has also refined the development of pressure layers.

Calculation of cumulative pressures and impacts

For the Baltic Sea Impact Index, BSII, each pressure (P) and ecosystem component (E) pair within a 1 km × 1 km assessment unit is multiplied by their specific sensitivity score (S) and the multiplied values within an ecosystem component (P×S) are summed together (∑(P×S)). If a certain ecosystem component does not exist in the assessed grid cell, the result was zero and does not affect the index score. A grid cell may include several ecosystem components.

The BSII can produce three types of outcomes, all arising from the fact that several ecosystem components can exist in an assessment unit. The different outcomes depend on the method of combining the 'impacted ecosystem components': (1) summing all the impacted ecosystem components per assessment unit, (2) taking an average cumulative impact of the impacted ecosystem components or (3) selecting most impacted ecosystem component.

1. Using the sum of all impacted ecosystem components within an assessment unit (the 1 km × 1 km grid cell) will result in an increase of the index score in areas of high biodiversity. This outcome indicates potentially important areas under high threats. This has previously been used in the first HELCOM holistic assessment (HELCOM 2010a) and many other sea regions (Halpern et al. 2008, Coll et al. 2012, Andersen et al. 2013, Micheli et al. 2013).
2. The average impact means that the end result does not indicate highly (or little) impacted ecosystem components, but shows the mean cumulative impact. This has recently been applied in a global assessment (Halpern et al. 2015).
3. The last alternative outcome emphasizes the most sensitive ecosystem component per assessment unit and all the other information is omitted from the BSII result.

The Baltic Sea Pressure Index, BSPI, calculates only cumulative pressures whereas ecosystem components are not included. Hence, no sensitivity scores are required. The pressures are, however, weighted by average sensitivity scores from the BSII in order to get a more balanced view of their significance to the marine environment.

Both the indices were computed by the EcoImpactMapper software (Stock 2016). The software uses input data in csv-format, which were the center points of the assessment grid cells. Therefore the raster maps of pressures and ecosystem components were transformed to points and, after computing, transformed again into raster format to visualize the results.

Data used in the BSII and BSPI assessments

Data sources

The assessments are based on regionally agreed lists of human activities, pressures and ecosystem components, using nationally approved data. The spatial data used will be presented as supporting material to HOLAS II, as fact sheets.

- The data on human activities and pressures are used as a base for the assessment, and are aligned with the indicative lists given in the revised Annex III of the MSFD (see Document 4-3-Add1 of HOLAS II 5-2016). The pressure layers used in the assessment developed based on these sources are listed in **Annex 1**. The details on how they were produced is described in more detail below and in **Annex 2**.
- The ecosystem components reflect key benthic and pelagic habitats in the Baltic Sea (on different levels of EUNIS biotope classification), habitats of functional importance (e.g. for reproduction) and species distribution models (See Table 1 of **Annex 1**).

The BSII uses sensitivity scores which are development through an expert survey and literature reviews, as described below.

Development of the pressure layers

The pressure layers used as input in this assessment are aggregated pressure types, which are based on several subtypes, each potentially caused by several different human activities. The outline of linkages between human activities, pressures and ecosystem components also allow for back-tracking impacts to pressures and activities. Such linkage frameworks, or impact chains (Knights et al. 2013), have been developed in several European research projects and were adapted for this assessment.

The development of these pressure layers is not always straightforward, and they are in some cases only indicative of the actual level and extent of the pressure in the marine environment, depending on the availability of underlying information. The text below describes what aspects were considered in the development of the spatial pressure layers. **Annex 2** gives the full list of pressure layers and all steps required to produce them.

Each pressure layer will be described in pressure fact sheets available as supporting material to HOLAS II.

Spatial extents

The pressures require a spatial extent. Many of the data layers in the assessment show the location of human activities but do not usually indicate the spatial extent of pressures stemming from the concerned activity. To represent the resulting pressures in a more realistic way, the spatial extents of pressures stemming from different human activities was estimated based on information from an expert survey conducted by the TAPAS project, supported by a literature study by the BalticBOOST project. In addition, for pressures that attenuate at increasing distances from their source, the spatial representation of the pressures needs to incorporate the correct form of this decline. Information on this form was taken from scientific literature and the question was also included in the TAPAS expert survey. The spatial extents and form of attenuation were assigned to the resulting spatial pressure layers, are listed in **Annex 2** and are also described in the pressure fact sheets.

Water depth and seabed exposure

Water depth and seabed exposure influence the pressure intensity in some cases. This does not apply to all pressure types, but may have significant consequences on the others. The approach was recently tested for the Finnish Archipelago Sea (Sahla 2015) and was further developed for the HOLAS II. The main purpose of considering these extra factors was to avoid over-representing impacts from some pressures on more exposed areas or deeper sea areas. The pressures affected by seabed exposure and water depth were identified and simple attenuation curves were assigned to the relevant pressures. These are described in **Annex 2** and the pressure fact sheets.

Temporal aspects

The pressure data layers need to encompass the specified assessment period (2011-2015 (updated to also represent 2016 later, as needed) and to give a representative indication of the annual sum of the pressure in the assessment unit. The latter requirement was defined specifically for each pressure so that they more accurately represent continuous, seasonally relevant or intermittent pressures. The simplest approach is to consider if there is additivity of the pressures over time; for pressures that last long (e.g. loss of a habitat) the assessment value will be the accumulated value for all years during the entire assessment period (2011-2016). For more temporary pressures the pressure levels may be annual sums or annual averages which are then averaged over the years of the assessment period. For instance, summing of pressure magnitudes within a year can distinguish areas of continuous or intermittent pressures. These are described in **Annex 2** and the pressure fact sheets.

The ecosystem components – species or habitats – can also be affected by temporal issues. For instance, seasons can affect the sensitivity of species and habitats:

- during the breeding time a species may be highly affected by pressures occurring near the breeding area, whereas the impact may be smaller during other times of year;
- annual vegetation in shallow areas may be more sensitive to pressures during the growth season than during the resting stage.

In the holistic assessment, it was not, however, possible to discern the pressures to seasonal values, as some source data was given as annual data.

Balancing the pressure source data

The HELCOM BalticBOOST Workshop on Physical loss and damage to the seafloor (June 2016, Copenhagen) discussed the problem of unbalance in the pressure magnitude from different activities and the biases this may cause to a cumulative impacts assessment. For example, shipping causes a certain amount of resuspension of sediment (causing physical disturbance). According to the BSII method this activity is quantified on the basis of the ship traffic and the resulting pressure scale is normalized to 0-1 scale. The same pressure (physical disturbance) is also caused by dredging and the pressure scale is based on the amount of dredged material and then normalized to the 0-1 scale. As a result, both activities result in a pressure which is expressed on the same scale although in reality the magnitudes of the pressures are different (e.g. dredging causes much higher turbidity and sedimentation).

The development of pressure layers followed the method suggested by the TAPAS project and was applied to the physical disturbance pressure by the BalticBOOST project. This is a three-step procedure:

- When aggregating spatial data sets, human activities causing the same pressure are ranked according to the magnitude of the pressure they are causing. This ranking was made for the physical disturbance pressure on seabed on the basis of the literature review by BalticBOOST project (Korpinen et al. 2017);

- The ranked activities (per pressure) are classified to 6 categories expressing the magnitude of the pressure. The categories are defined as percentages of the maximal occurring pressure;
- The percentages are used as weights for each of the activities when shaping the pressure layers.

The proposed approach decreases over-presentation of any activities in the pressure layer and thus increases the reliability of the BSII outcome.

Sensitivity scores

Expert survey

The expert survey to support the setting of impact scores was developed in Microsoft Excel together with a guidance document and guidance text. The survey is closed but can be studied at the project page of HOLAS II.

In the expert survey, 19 pressures and 40 ecosystem components were covered, resulting in a matrix of 750 potential pressure- and ecosystem-specific combinations. In order to calculate as robust pressure- and ecosystem component specific sensitivity scores as possible, the questionnaire addressed the following 6 themes: (1) Tolerance/resistance, (2) Recoverability, (3) Sensitivity, (4) Impact distance, (5) Impact type and (6) Confidence.

Participants were asked to give a reply regarding these aspects in three classes: High, Medium and Low, or to give = for "no impact". The survey included an explanatory text to each theme.

The participants were also asked to give answers in the impact distance of the concerned human activity, and the impact type, to support the refinement of selected pressure layers (see above).

Third, participants were asked to self-evaluate the confidence of their response. According to the guidance, *low confidence* should be assigned if the evaluation was supported by limited or no empirical documentation (e.g. judgement is based on inference from other, similar ecosystem components/pressure types or from knowledge on the physiology and ecology of the species etc.), *moderate confid*ence if documentation is available, but results of different studies may be contradictory (e.g. including also grey literature with limited scope), and *high confidence* should be given if documentation is available and with relatively high agreement among studies.

The survey replies were processed to medians and means. The 'sensitivity' field was used as the main basis for the final sensitivity scores, but the responses to 'tolerance' and 'recoverability' were analysed to find inconsistencies in the replies. In addition, the 'confidence' replies and the number of replies per score were used as to guide whether the sensitivity score was reliable.

Literature-based support the expert survey

The final sensitivity scores are a combination of the results of the expert survey and results of a literature review which was made under the BalticBOOST project (Korpinen et al. 2017). The BalticBOOST literature review of human activities evaluated impacts on benthic habitats and species and recovery times associated with those impacts. The information was given in a catalogue which lists all the literature references and their main results but also in more condensed form which can easily support overall conclusions of the sensitivity of benthic features to pressures. The BalticBOOST catalogue was used to support the development of sensitivity scores. Although the approach was mainly limited to benthic habitats, the literature review gave some support also to pelagic habitats, mammals, seabirds and fish.

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Annex 1. Data layers used in the BSII

Table 1: Ecosystem components
1. Productive surface waters
2. Oxygenated deep waters
3. Infralittoral hard bottom
4. Infralittoral sand
5. Infralittoral mud
6. Circalittoral hard bottom
7. Circalittoral sand
8. Circalittoral mud
9. Furcellaria lumbricalis
10. Zostera marina
11. Charophytes
12. Mytilus edulis
13. Fucus sp.
14. Sandbanks which are slightly covered by sea water at all time (1110)
15. Estuaries (1130)
16. Mudflats and sandflats not covered by seawater at low tide (1140)
17. Coastal lagoons (1150)
18. Large shallow inlets and bays (1160)
19. Reefs (1170)
20. Submarine structures made by leaking gas (1180)
21. Baltic Esker Islands (UW parts, 1610)
22. Boreal Baltic islets and small islands (UW parts, 1620)
23. Cod abundance
24. Cod spawning area
25. Herring abundance
26. Sprat abundance
27. Distribution of demersal spawning flounder
28. Abundance of pelagic spawning flounder
29. Recruitment areas of perch
30. Recruitment areas of pikeperch
31. Recruitment areas of roach
32. Wintering seabirds
33. Breeding seabird colonies
34. Migration routes for birds
35. Grey seal abundance
36. Grey seal haulouts
37. Harbour seal abundance
38. Harbour seal haulouts
39. Ringed seal distribution
40. Distribution / density of harbour porpoise

Table 2: Pressure layers
1. Physical loss (permanent effects on the seabed)
2. Physical Disturbance or damage to seabed (temporary or reversible effects)
3. Changes to hydrological conditions (e.g. by constructions impeding water movements)
4. Inputs of continuous anthropogenic sounds (into water)
5. Inputs of impulse anthropogenic sound (into water)
6. Inputs of other form of energy (electromagnetic and seismic waves)
7. Input of heat (e.g. by outfalls from power stations) into water
8. Inputs of hazardous substances
9. Inputs of nutrients
10. Introduction of radionuclides
11. Oil slicks and spills
12. Inputs of litter
13. Inputs of organic matter
14. Disturbance of species due to human presence
15. Extraction of, or mortality/injury to fish
16. Extraction of, or mortality/injury to mammals and seabirds (e.g. hunting, predator control)
17. Introduction of non-indigenous species and translocations
18. Changes in climatic conditions
19. Acidification

Annex 2. Specifications for production of the pressure layers

1. Physical loss (permanent effects on the seabed)

Aggregation method: Activities are combined and potentially overlapping areas are removed. Combined layer is intersected with 1 km grid to calculate % of area lost within a cell

Temporal nature: Cumulative (summed over the period)

Spatial datasets to be combined	Spatial extent	Data used for analysis / data processing	Depth / exposure adjustment
Land claim	Area of polygon or 50 m buffer for points, 30m buffer for lines	Calculate area lost (polygon). In a grid cell: calculate proportion of the cell area.	Not relevant
Water course modification	50 m buffer	Calculate buffer to indicate lost area. In a grid cell: calculate proportion of the cell area.	Not relevant
Coastal defence and flood protection	50 m buffer for lines, 100 m buffer for points	Calculate buffer to indicate lost area. In a grid cell: calculate proportion of the cell area.	Not relevant
Extraction of sand and gravel	area of polygon	Calculate area lost (polygon). In a grid cell: calculate proportion of the cell area.	Not relevant
Oil platforms	25 m buffer	Calculate buffer to indicate lost area. In a grid cell: calculate proportion of the cell area.	Not relevant
Pipelines	15 m buffer	Calculate buffer to indicate lost area. In a grid cell: calculate proportion of the cell area.	Not relevant
Wind farms	30 m buffer around each turbine	Calculate area lost (polygon). In a grid cell: calculate proportion of the cell area.	Not relevant
Cables	1.5 m buffer	Calculate buffer to indicate lost area. In a grid cell: calculate proportion of the cell area.	Not relevant
Harbours	polygon with 200 m buffer	Calculate area lost (polygon). In a grid cell: calculate proportion of the cell area.	Not relevant
Marinas and leisure harbours	point with 200 m buffer	Calculate buffer to indicate lost area. In a grid cell: calculate proportion of the cell area.	Not relevant
Bridges	2 m buffer	Calculate buffer to indicate lost area. In a grid cell: calculate proportion of the cell area.	Not relevant
Bathing sites, beaches	300 m buffer	Calculate buffer to indicate lost area. In a grid cell: calculate proportion of the cell area.	Not relevant
Oil terminals, refineries	point with 200 m buffer	Calculate buffer to indicate lost area. In a grid cell: calculate proportion of the cell area.	Not relevant
Finfish mariculture	150 m buffer	Calculate buffer to indicate lost area. In a grid cell: calculate proportion of the cell area.	Not relevant
Shellfish mariculture	area of polygon	Calculate buffer to indicate lost area. In a grid cell: calculate proportion of the cell area.	Not relevant

2. Physical disturbance or damage to seabed (temporary or reversible effects)

Aggregation method: Spatial extents, including spatial attenuation of the pressures, are calculated per specific data sets. Mean pressure intensity per grid cell is assigned to the grid cell. The final grid cell intensity is downweighted (by areal %) if the pressure area is smaller than the grid cell. Activities are weighted according to the method described in the document. All the pressure intensities of specific pressure layers are summed per grid cell.

Temporal nature: Temporary (averaged between the years)

Spatial datasets to be combined	**Spatial extent**	**Data used for analysis / data processing**	**Depth / exposure adjustment**
Shipping density	AIS data calculated directly to 1 km grid cells. **Impacts 2 km from the line with a linear decrease.**	Average of total shipping density in a 1km x 1 km cell 2011-2014, log-transformed, normalized.	rescaled with depth: 0-10 m= 100% 10-15 m= 50% 15-20 m= 25% 20-25 m= 10% 25m < =0%
Recreational boating and sports	Total fuel consumption of recreational boats modelled directly to 1 km grid cells. **No spatial impact outside grid cells..**	Total fuel consumption of leisure boats modelled in SHEBA project. Fuel usage range in a 1km x 1 km cell in 2014, log-transformed, normalized.	rescaled with depth: 0-5m= 100% 5-7 m= 70% 7-10 m= 50% 10-15 m= 10% 15m < =0%
Extraction of sand and gravel	**3 km buffer with sharp decline after 0.5 km (type D response)**	Average amount of extracted material over years, if value missing, 25% percentile of the existing information is given, normalized	Weighted by the exposure map
Dredging	**3 km buffer with sharp decline after 0.5 km (type D response).** Converted directly to 1 km grid cells.	Average amount of dredged material over years, if value missing 25% percentile of the existing information is given, normalized	Weighted by the exposure map
Deposit of dredged material	**3 km buffer with sharp decline after 0.5 km (type D response).** . converted directly to 2 km grid cells	Average amount of deposited material 2011-2014, if value missing 25% percentile of the existing information is given, normalized	Weighted by the exposure map
Bathing sites, beaches	1 km buffer considered, point data on beaches converted directly to 1 km grid cells.	Amount of bathing sites in a cell, normalized	Not relevant
Wind farms (construction)	**1 km buffer with sharp decline after 0.5 km** for windfarms under construction, polygon data converted directly to 1 km grid cells.	Location of wind farms under construction	Weighted by the exposure map
Wind farms (operational)	**0.3 km buffer with linear decline.**		
Cables (construction)	**1 km buffer with sharp decline after 0.5 km** for cables under construction, line data converted directly to 1 km grid cells	Location of constructed cables, rescaled intensity to 0.6	Weighted by the exposure map
Pipelines (operational)	**0.3 km buffer with linear decline.**		
Potting / creeling	Eventually 0.05 x 0.05 c-square degree grid (reporting unit for VMS data from ICES)	Average of potting/creeling intensity in 2011-2015 log-transformed and normalized (not included in initial tests)	Not relevant
Demersal long lining	0.05 x 0.05 c-square degree grid (reporting unit for VMS data from ICES)	Average of seabed surface contacting gear fishing intensity (Surface area ratio) in 2011-2013, log-transformed, normalized	Not relevant
Bottom trawling	0.05 x 0.05 c-square degree grid (reporting unit for VMS data from ICES)	Average of seabed surface contacting gear fishing intensity (Surface area ratio) in 2011-2013, log-transformed, normalized	Not relevant
Demersal Danish seining	0.05 x 0.05 c-square degree grid (reporting unit for VMS data from ICES)	Average of seabed surface contacting gear fishing intensity (Surface area ratio) in 2011-2013, log-transformed, normalized	Not relevant

Demersal Scottish seining	0.05 x 0.05 c-square degree grid (reporting unit for VMS data from ICES)	Average of seabed surface contacting gear fishing intensity (Surface area ratio) in 2011-2013, log-transformed, normalized	Not relevant
Water course modification (construction)	No watercourse modification under construction reported	No watercourse modification under construction in 2011-2015	Not relevant
Coastal defence and flood protection (construction)	500 m buffer considered, point and line data converted directly to 1 km grid cells	Location of coastal defence and flood protection under construction	Weighted by the exposure map
Finfish mariculture	**1 km buffer linear decline**, point data converted directly to 1 km grid cells	Average P load 2011-2015, if values missing 25% percentile of the remaining was given, normalized	Weighted by the exposure map
Shellfish mariculture	**1 km buffer linear decline**, polygon data converted directly to 1 km grid cells	Average production in 2011-2015, if values missing, 25% percentile of the remaining was given, normalized	Weighted by the exposure map
Maerl and Furcellaria harvesting	No buffer considered, polygon data converted directly to 1 km grid cells	Calculated amount/area of harvested material, normalized	Not relevant
Scallop and blue mussel dredging	No buffer considered, polygon data converted directly to 1 km grid cells	Sum of scallop and blue mussel dredged per year, averaged for 2011-2015, normalized	Not relevant

3. Changes to hydrological conditions (e.g. by constructions impeding water movements

Aggregation method: Spatial extents and potential attenuation gradients are assigned to the specific pressure layers. They are merged (by affected area, km2) to avoid overlapping areas. Intersected with 1 km grid to calculate % of area affected within a cell.

Temporal nature: Cumulative (summed over the period)

C. Spatial datasets to be combined	D. Spatial extent	E. Data used for analysis / data processing	F. Depth / exposure
Hydropower dams	a grid cell in the estuary	locations of hydropower dams - those that are operational and produces energy	Not relevant
Water course modification	1 km buffer	Location of water course modifications	Not relevant
Wind farms	**300 m buffer around each turbine with linear decline**	Location of operational wind farms as polygons	Not relevant
Oil platforms	**300 m buffer around each turbine with linear decline**	Location of oil platforms as points	Not relevant

4-7 Input of continuous and impulsive anthropogenic sounds, other form of energy, heat

Aggregated pressure	Temporal nature	Spatial datasets to be combined	Spatial extent	Data used for analysis / data processing	Depth / exposure	Aggregation method
Inputs of continuous anthropogenic sounds (into water)	temporary	Ambient underwater noise	BIAS project ambient underwater noise data modelled into 0.5 km x 0.5 km grid	Ambient underwater noise of frequencies of 63, 125 and 2000 Hz exceeding noise levels 95% of the time in full water column during 2014	Not relevant	Average of decibels of 3 different frequencies
Inputs of impulsive anthropogenic sound (into water)	temporary	Impulsive noise events	Data converted directly to 1km grid cells	Data from HELCOM-OSPAR Database for impulsive noise and national data call (polygons, points, lines) with noise values categorized from very low, low, medium, high and very high	Not relevant	Average of events based on noise value codes
Inputs of other form of energy (electromagnetic waves)	temporary	Cables	No buffer considered, line data converted directly to 1 km grid cells	Location of cables	Not relevant	Not relevant
Input of heat (e.g. by outfalls from power stations) into water	temporary	Discharge of warm water from nuclear power plants	**1 km buffer with linear decrease around outlet**	Average input of warm water (Degrees C) from the nuclear power plant outlets	Not relevant	Sum of the input of warm water.
		Fossil fuel energy production (only location available)	**1 km buffer with linear decrease around outlet**	Average input of warm water (Degrees C) from the nuclear power plant outlets	Not relevant	

8, 10 and 11. Input of hazardous substances Introduction of radionuclides, and i Oil slicks and spills

Aggregated pressure	Temporal nature	Spatial datasets to be combined	Spatial extent	Data used for analysis / data processing	Depth / exposure	Aggregation method
Input of hazardous substances	temporary	CHASE Assessment tool concentration component: results per assessment unit	HELCOM assessment units	Contamination Sum of the CHASE Assessment tool concentration component	Not relevant	Not relevant
Introduction of radionuclides	temporary	**10 km buffer with linear decline from d**ischarges of radioactive substances	Gradual buffer around outlet to 10 km distance	Annual averages of CO60, CS137 and SR90 from the period 2011-2015 per nuclear power plant. Aggregation to be agreed intersessionally between HELCOM Mors Expert group and the Secretariat.	Not relevant	Not relevant
Oil slicks and spills	temporary	**15 km buffer with linear decrease.** Oil slicks and spills from ships and oil platforms	Buffer area depending on reported spill area	If oil spill volume was missing (67/560), median of the rest was given. If area of spill was missing (103/560), mean of the existing was given. If the spill was < 1km2, the value of spill volume was given directly to 1km2 grid cell. If the spill area > 1km2, the estimated volume of the spill was divided by the spill area to get the estimated amount of oil / km2. This value was given to the entire spill area.	Not relevant	sum of spill volume
		15 km buffer with linear decrease. Polluting ship accidents	point, converted directly to 1 x 1 km grid	9/24 accidents with oil spills were missing spilled oil volume, thus a mean of reported volumes was given to accidents with missing oil volume. Spill volume in m3 was converted to grid	Not relevant	

12 Input of litter

Aggregated pressure	Temporal nature	Spatial datasets to be combined	Spatial extent	Data used for analysis / data processing	Depth / exposure	Aggregation method
Inputs of litter[1]	temporary	Beach litter	points converted directly to 1 x 1 km grid	Beach litter indicator to be used as proxy for pressure. Presence/absence of beach litter	Not relevant	Sum of presence of beach litter and litter on sea floor
		Bottom trawled litter from seafloor	information converted directly to 1 x 1 km grid	DATRAS database on trawl surveys (ICES)	Not relevant	

9, 13 Input of nutrients, input of organic matter

Aggregated pressure	Temporal nature	Spatial datasets to be combined	Spatial extent	Data used for analysis / data processing	Depth / exposure	Aggregation method
Inputs of nutrients	temporary	Interpolated nitrogen and phosphorus concentrations	Mean value per grid cell	N and P concentrations	Not relevant	Not relevant (separate data layers)
Inputs of organic matter	temporary	**10 km with linear decrease.** Riverine input of organic matter	plume based on satellite images	concentration based on different proxies (e.g. BOD, COD values)	Weighted by the exposure map	Not relevant

14. Disturbance of species due to human presence

Aggregation method: Specific pressure layers first modified by spatial extents and depth influence. Each of them is considered as of equal importance (same weight). Calculate the sum of the pressure in a cell.

Temporal nature: temporary

Spatial datasets to be combined	Spatial extent	Data used for analysis / data processing	Depth / exposure
500 m buffer. Recreational boating and sports	Total fuel consumption of recreational boats modelled directly to 1 km grid cells.	Total fuel consumption of recreational boats presented as presence / absence	rescaled with depth: 0-10m= 100% 10-15 m= 70% 15-20 m= 50% 20-30 m= 20% 30-40 m = 10% 45m < =0%
1 km buffer. Bathing sites, beaches	point data converted directly to 1 km grid cells	Location of beaches presented as presence / absence	Not relevant
1 **km buffer.** Marinas and leisure harbours	point data converted directly to 1 km grid cells	Location of marinas and leisure harbours presented as presence / absence	Not relevant
1 km buffer. Game hunting of seabirds	polygon data converted directly to 1 km grid cells	Game hunting of seabirds presented as presence / absence	Not relevant
1 km buffer. Predator control of seabirds	polygon data converted directly to 1 km grid cells	Predator control of seabirds presented as presence / absence	Not relevant
1 km buffer. Hunting of seals	polygon data converted directly to 1 km grid cells	Hunting of seals presented as presence / absence	Not relevant
5 km buffer. Urban land use	polygon data converted directly to 1 km grid cells	presence / absence	Not relevant
5 km buffer. Population density	coastal population density polygon data converted directly to 1 km grid cells	presence / absence	rescaled with depth: 0-4m= 100% 4-7 m= 70% 7-10 m= 50% 10-20 m= 20% 20m < =0%

[1] There is no available data to develop a spatial layer representing marine litter.

15-17. Extraction of, or mortality/injury to fish, seabirds, mammals, Introduction of non-indigenous species and translocations

A. Aggregated pressure	B. Temporal nature	C. Spatial datasets to be combined	D. Spatial extent	E. Data used for analysis / data processing	F. Depth / exposure	G. Aggregation method
Extraction of, or mortality/injury to fish	temporary	**0 km.** Extraction of target fish species (cod, herring, sprat, flounder) in commercial fishery	Reported per ICES Rectangles, covers the whole Baltic Sea	Extraction of fish species (landings) per ICES rectangle, average of 2011-2014. Landings calculated per km2.	Not relevant	Log transformed. For cod, recreational fisheries catches were added (see below).
		0 km. Extraction of fish species by recreational fishery	Reported per country for eel, cod and salmon (tonnes).	Extraction of fish species by recreational fishing, average of 2011-2014. For cod, recreational landings (tonnes/km2) were added to commercial catches.	Not relevant	Tonnes/km2 values for cod, summed with tonnes/km2 values from commercial catches. Log transformed.
Extraction of, or mortality/injury to seabirds (e.g. hunting, predator control)	temporary	**0 km.** Game hunting of seabirds	Varying reporting units, from counties to HELCOM subdivisions	Species summed together, average of killed seabirds of years 2011-2015 per reporting unit, numbers of killed birds / km2 calculated and generalized for the whole reporting unit, normalized	Not relevant	normalized values summed together
		0 km. Predator control of seabirds	Varying reporting units, from counties to HELCOM subdivisions	Total number of killed cormorants per year averaged for 2011-2015, numbers of killed birds / km2 calculated and generalized for the whole reporting unit, normalized	Not relevant	
Extraction of, or mortality/injury to mammals	temporary	**0 km.** Hunting of seals	Varying reporting units, from counties to HELCOM subdivisions	Total number of killed seals (per species) averaged for 2011-2014, numbers of killed seals/ km2 calculated, and generalized for the whole reporting unit, normalized	Not relevant	Not relevant (as the species are presented separately in the ecosystem components)
Introduction of non-indigenous species and translocations	cumulative	**50 km buffer**. Spread of non-indigenous species	Reported per coastal areas	Number of NIS per HELCOM sub-basins and coastal areas, generalized for the whole reporting unit.	Not relevant	Not relevant

18-19. Change in climatic conditions, Acidification

A. Aggregated pressure	B. Temporal nature	C. Spatial datasets to be combined	D. Spatial extent	E. Data used for analysis / data processing	F. Depth / exposure	G. Combination method
Change in climatic conditions		**50 km buffer.** Long term change in sea surface salinity (PSU), and sea surface temperature (degrees Celsius)	Point data covering the Baltic Sea	Long-term monitoring data on sea surface salinity and temperature from ICES database. Coastal monitoring sites (<2km to land) excluded. Mean of July-August values at 10m depth (surface) calculated for 1960-2010 (presenting long-term) and for 2011-2015 (assessment period) per HELCOM sub-basin. Change in temperature and salinity calculated. Temp. increase is expected with climate change, thus subbasins showing decrease are given 0 values. Data normalized. Salinity decrease is expected with climate change, thus subbasins showing increase, are given 0 values. Data normalized.	Not relevant	Not summed (as change in temperature is likely to have different effects on the ecosystem, than change in salinity)
Acidification		**50 km buffer.** Long term change in pH	Point data covering the Baltic Sea, some sub-basins missing data on pH (Great Belt, the Sound, Kiel Bay, Arcona Basin)	Long-term monitoring data on pH from ICES database. Coastal monitoring sites (<2km to land) excluded. Mean of July-August values at 10m depth (surface) calculated for 1960-2010 (presenting long-term) and for 2011-2015 (assessment period) per HELCOM sub-basin. Change in pH calculated. Normalized.	Not relevant	Not relevant