Task 4.1.1: A step-wise method guideline for carrying out a technical assessment of the lost, disturbed and adversely affected area (km2) of benthic and pelagic habitat types from different activities.

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Contents

1. Introduction

The HELCOM holistic assessment of the ecosystem health is built around a set of core indicators which give quantitative measures of the state of the indicator. Currently, the benthic habitats lack core indicators because of knowledge lacks on quantitative methods assessing the state and extent of habitats and pressures adversely affecting them. Also the EU Marine Strategy Framework Directive (MSFD) has a focus on the state of habitats which is especially emphasized in the recent Commission Decision for the criteria and methodological standards of good environmental status (GES). Under SPICE theme 4, different approaches were tested and developed to support the setting of appropriate assessment levels, their integration, and threshold values for when a habitat can be considered adversely affected.

One of the central outcomes of HELCOM's BalticBOOST (HELCOM 2016a) and TAPAS projects was to improve the estimation of the spatial extent, as well as outline the impacts of, pressures and the subsequent proposal for practical applications of the project results, supporting the development of assessments of pressures on benthic habitats by human activities. The results of BalticBOOST also assist the process of setting environmental targets for pressures affecting the seabed as well as support the assessment of benthic habitats under the revised EU Commissions Decision 2017/848 (EC 2017) hereafter referred to as COM DEC.

The pressures, and by extension their associated human activities, have been categorised as follows in the revised Marine Strategy Framework Directive (MSFD):

Physical loss in the revised MSFD Annex III, has been defined as '*physical loss due to permanent change of seabed substrate or morphology and to extraction of seabed substrate*'. Moreover, the revised COM DEC, defines this as '*a permanent change to the seabed which has lasted or is expected to last for a period of two reporting cycles (12 years) or more*'.

Physical disturbance to seabed is listed in the revised MSFD Annex III and is further defined in the revised COM DEC as '*Physical disturbance shall be understood as a change to the seabed which can be restored if the activity causing the disturbance pressure ceases*'. This suggests that the temporal aspect defining disturbance can be established on the basis of the habitat component's recovery time being <12 years.

The MSFD criteria for physical loss (D6C1) and physical disturbance (D6C2) respectively, require an assessment of the spatial extent of seabed area being lost or disturbed. The results of BalticBOOST supported this spatial analysis by suggesting distances for the pressures to affect the seabed and water column habitats.

Further, the MSFD describes **adverse effects** on habitat condition as '*alterations in its biotic and abiotic structure and its functions'.* The MSFD criterion for adverse effect (D6C3) requires an assessment of the spatial extent of benthic habitats being adversely affected by physical disturbance, eutrophication, hypoxia or litter. However, so far, the definition of adverse effects for different pressure – habitat combinations hasn't been established. Also, the respective spatial distance thresholds or temporal exposure thresholds to benthic habitats require more work.

SPICE is building on the results of BalticBOOST and TAPAS and has developed and compiled definitions, thresholds and ranges of the impacts of pressures caused by human activities, and adversely affecting benthic habitats. This is a prerequisite for the full assessment of the state of benthic habitats also shown by the revised GES criteria D6C4 stating *'The extent of loss of the habitat type, resulting from anthropogenic pressures, does not exceed a specified proportion of the natural extent of the habitat type in the assessment area'* and criteria D6C5 listing *'The extent of adverse effects from anthropogenic pressures on the condition of the habitat type, including alteration to its biotic and abiotic structure and its functions (e.g. its typical*

species composition and their relative abundance, absence of particularly sensitive or fragile species or species providing a key function, size structure of species), does not exceed a specified proportion of the natural extent of the habitat type in the assessment area.'

SPICE theme 4 aimed at establishing clear thresholds for adverse effects on benthic and pelagic habitats to improve the assessment of the environmental status and promote practical applications and guidelines to safeguard GES. While a certain amount of pressure may adversely affect an ecosystem component, i.e. altering its biotic and abiotic structure or function (*sensu* D6C3, D6C5), it may still be tolerable to match the criteria for GES (Figure 1). However, if a tolerable threshold of the pressure is exceeded, either in strength or spatio-temporal extent, then adversely affected habitats become sub-GES classified or even meet the criteria for being disturbed or lost. The exploration of these thresholds and their application for habitat assessments is the central task of SPICE's WP 4 (Figure 1).

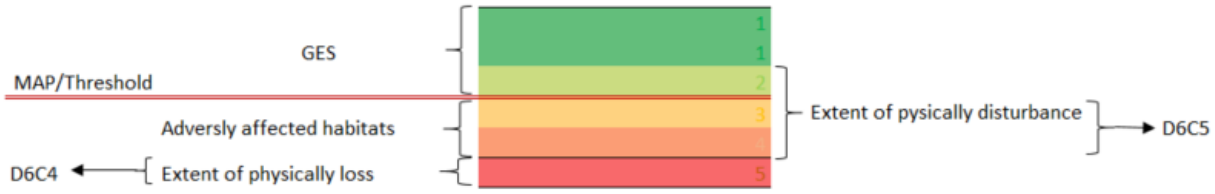

Figure 1: Conceptual visualisation of adversely affected, disturbed and lost habitats in relation to GES (Good Environmental Status) and MAP (Maximum Allowable Pressure).

1.1 Pelagic habitats

For benthic habitats, SPICE WP 4 delivers recommendations for an assessment starting point, considering thresholds for future assessments. However, currently there are no clear definitions of pelagic habitats in the Baltic Sea. The HELCOM State of the Baltic Sea report considered the pelagic habitat as a single habitat type that was assessed on sub-basins scale with a division to offshore and coastal areas (HELCOM 2017a). Technically, the same method guidelines as for benthic habitats can be used, but definitions of pelagic habitats need to be established in an ecological meaningful manner. So far, HELCOM distinguishes between coastal and offshore, photic and deep oxygenated zones within sub-regions. One suggestion by SPICE WP 4 researchers was to consider similar physical characteristics of waterbodies, such as salinity – a well-known factor structuring e.g. plankton communities, to define pelagic habitats and not solely describe them according to their geographical extent based on sub-regions. Due to the lack of clear definition and assessment strategies, most of the work carried out in SPICE WP 4 focuses on benthic habitats, but also provides information on pelagic habitats where applicable at the current state of knowledge.

2. Human activities and pressures

In SPICE WP 4 the following human activities, causing pressures and their respective effect distances on benthic habitats are considered:

- Dredging (capital and maintenance)
- Sand and gravel extraction
- Disposal of dredged matter
- Shipping and ferry traffic
- Harbours
- Leisure boating

- Marinas
- Mariculture (fish farms)
- Shoreline exploitation
- Jetties, breakwaters, etc.
- Potentially polluted areas
- Environmentally hazardous business
- Wind turbines (operational)
- Mobile bottom contacting gears

BalticBOOST provided an extended catalogue of human activities on seabed habitats, based on a broad literature review, including information of the type of activity, pressure it is causing, intensity of the pressure, lasting of the pressure, target of the impact, type of impact, magnitude of the impact, spatial extent of the impact, recovery from the impact, region of the study, type of study, and reference to the study cited. The synthesis of this catalogue can be accessed in BalticBOOST WP3 report's Annex 2. Different human activities are causing environmental pressures affecting benthic and pelagic habitats. Based on the SPICE results detailed in WP 4.2.1, a synthesis table of the possible indicators related to pressures to be used for describing the quality of adversely affected benthic and pelagic habitats is provided (Table 1). The compilation of the suggested pressures is based on defined thresholds and tolerable ranges of ecosystem components to the pressure. It can serve as advice for a standardized assessment approach when considering which pressures to include when assessing specific ecosystem components. As the definition for pelagic habitats is still under discussion, table 1 only provides recommendations based on expert knowledge for pelagic habitats but cannot deliver specific thresholds.

Table 1: SPICE WP4 compiled and analysed list of pressures, including their thresholds, to be used for assessing habitat quality of adversely affected ecosystem components of benthic and pelagic habitats. For details see 4.2 of this report. H_2S = hydrogen sulphide, TN = total nitrogen, TP = total phosphorus, DIN = dissolved inorganic nitrogen, DIP = dissolved inorganic phosphorus.

Ecosystem components		**Oxygen**	**H2S**	**Secchi depth**	**Turbidity**	**Suspended solid matter**	**Distance from**	**Sediment Organic**	**TN**	**TP**	**DIN**	**DIP**	**Urban Effluents**
Benthic habitats	Dominant benthic species	+	+										
	BBI	+			+	+	+	+	+	+			
	BQI	+											+
	Macrophytes				+	+			+	+			
Pelagic habitats*				+					+	+	+	+	

*no thresholds or analysis available

3. Assessment level

With no clear agreement within HELCOM regarding the detail of habitats needed to be assessed through indicators, project related analysis and results are fundamental in advancing recommendations for all HELCOM contracting parties. The HELCOM HUB classification (HELCOM 2013) has been developed to enable the use of more detailed levels of biotopes (down to level 6, which is defined by dominant taxa, see table 2) in a structured and data driven manner, while also allowing for the smoother transfer of the Baltic units to the European habitat classification system, EUNIS. HELCOM HUB, therefore, represents a compromise

between an independent Baltic classification system and EUNIS. HELCOM HUB Level 5 biotopes are best comparable to EUNIS Level 4 biotopes. However, HELCOM HUB biotopes may still require some adjustment to be fully compatible and transferrable to the EUNIS system.

Following the SPICE results, the recommended HUB classification for assessment of benthic habitats is level 6. Although the BalticBOOST and TAPAS projects advised a more pragmatic habitat classification level (substrate level, HUB 3) for use in the HOLAS assessment, SPICE highlights the need for a more detailed habitat classification to detect and determine pressure thresholds. The assessment results would, however, be presented for the broad habitat types, following the SPICE WP 4.1.2 integration rules (see section 3.1) and as required by the COM DEC. Besides the information on broad habitat type (reflecting level 3) which is too coarse for the assessment of adversely affected habitats, level 6 further comprises information on the community structure, characteristic communities associated with the habitat and the dominant taxa of the respective habitat (Table 2) (HELCOM 2013). Being aware that the data availability in such detail is internationally still scarce, HUB level 6 is still necessary in order to ascertain specific pressure thresholds, based on species sensitivities, and therefore needed for the assessment of adversely affected habitats.

Table 2: Overview of HUB level classification (HELCOM 2013).

HUB level	Habitat detail
1	Region
2	Vertical zones
3	Substrate
4	Community structure
5	Characteristic community
6	Dominating taxa

3.1 Integration of different levels of assessment

3.1.1 MSFD-HELCOM HUB

For developing a proposal for a translation matrix between MSFD and HELCOM HUB system available guidance documents were used (e.g. translation between MSFD and EUNIS systems provided in the new draft Commission Decision 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) and modified them according to Baltic Sea conditions. As HUB is hierarchical system and MSFD system covers only the very broadscale features of marine environment only one HUB level (level 3) was included in the translation matrix (Table 3).

The proposed translation was created based on links between MSFD broad habitat types and relevant EUNIS habitat codes on Commission Decision 2016, "ANNEX to the Commission Decision laying down criteria and methodological standards on good environmental status of marine waters and specifications and standardized methods for monitoring and assessment, and repealing Decision 2010/477/EU" and guidelines from Evans et al. 2014 "Crosswalks between European marine habitat typologies - A contribution to the MAES marine pilot".

Table 3. MSFD broad habitat types related with HUB habitats

MSFD	HUB level 3
Infralittoral rock and biogenic reef	AA.A Baltic photic rock and boulders AA.B Baltic photic hard clay AA.C Baltic photic marl (marlstone rock) AA.D Baltic photic maerl beds AA.E Baltic photic shell gravel AA.F Baltic photic ferromanganese concretion bottoms AA.G Baltic photic peat bottoms AA.K Baltic photic hard anthropogenically created substrates
Infralittoral coarse sediment	AA.I Baltic photic coarse sediment
Infralittoral mixed sediment	AA.M Baltic photic mixed substrate
Infralittoral sand	AA.J Baltic photic sand AA.L Baltic photic soft anthrophogenically created substrates*
Infralittoral mud	AA.H Baltic photic muddy sediment AA.L Baltic photic soft anthrophogenically created substrates*
Circalittoral rock and biogenic reef	AB.A Baltic aphotic rock and boulders AB.B Baltic aphotic hard clay AB.C Baltic aphotic marl (marlstone rock) AB.D Baltic aphotic maerl beds AB.E Baltic aphotic shell gravel AB.F Baltic aphotic ferromanganese concretion bottoms AB.G Baltic aphotic peat bottoms AB.K Baltic aphotic hard anthropogenically created substrates
Circalittoral coarse sediment	AB.I Baltic aphotic coarse sediment
Circalittoral mixed sediment	AB.M Baltic aphotic mixed substrate
Circalittoral sand	AB.J Baltic aphotic sand AB.L Baltic aphotic soft anthrophogenically created substrates*
Circalittoral mud	AB.H Baltic aphotic muddy sediment AB.L Baltic aphotic soft anthrophogenically created substrates*

* To be determined in each case separately

3.1.2 Development of guidelines of status assessment aggregation principles between hierarchical units

Current proposed methodology for identifying threshold values and assessment deals with hierarchical habitat classification systems. The aim is to transfer the status assessment result from the lowest hierarchical habitat classification system (level at which the classification of single stations is usually performed) to higher levels (HUB level 3) with translation to status of MSFD broad habitat types.

An important precondition of this method is that status assessment result on a particular HUB level is expressed in numerical value (e.g. assessment result can be expressed through EQR/BQR type of metric). Suitable metric to be used for this assessment is e.g. HELCOM indicator "Condition of benthic habitats" developed by the TAPAS project and HELCOM IN benthic habitat monitoring.

3.1.2.1 Selection of habitats.

There might be a wish to select particular HUB level 5/6 habitats for the assessment and not deal with all existing habitats. This might be very useful approach to conserve the effort (see table 4 for an example of how such habitats could be identified). As HUB is hierarchical system, each level 5/6 habitat is directly related to one level 3 habitat. So it is possible to select one or a couple of level 5/6 habitats most representative for the particular level 3 habitat for the assessment unit in question. There is an option to create the list of "important" HUB level 5/6 habitats for larger assessment areas (national waters/HELCOM basins/Baltic Sea). This list can be agreed among experts before actual large scale assessments are performed. In this case we assume that selected "important" HUB level 5/6 habitats are representative for the total variety of habitats and represent the overall status of benthic habitats in the assessment unit.

Of course, there is an opportunity to use all existing HUB level 5/6 habitats in the assessment unit applying the aggregation rules within the each hierarchical levels.

3.1.2.2 Proposal for stepwise procedure for hierarchical aggregation of the habitat status classification.

Aggregation of status classification of lower hierarchical classification levels should be carried out using following stepwise procedure:

Step 1. Status assessment of HUB level 5/6 habitat. This is performed using a metric expressing the final result in numeric value/ratio. In case of using HELCOM indicator "Condition of benthic habitats" the assessment procedure corresponds to principles and thresholds applied in the Habitats directive (HD) taking into account important properties of the habitat – area, distribution range and quality status (status of biological communities) of habitats.

Step 2. Further procedure depends on the use of: A) selected list of "important" HUB level 5/6 habitats, or B) using status classification of all available HUB level 5/6 habitats in the assessed sea area (assessment unit).

Option A). Assessment is done for single HUB level 5/6 "important" habitat. Aggregation for HUB level 4 and 3 is carried out by applying averaging of assessment ratio (EQR/BQR) of previous level.

Option B). Assessment is done for each HUB level 5/6 habitat available in assessment unit. Aggregation for HUB level 4 is carried out using weighted averaging using HUB level 5/6 habitat area as weighting factor. Aggregation to level 3 is done through averaging the assessment ratio of level 4.

Step 3. Transfering the assessment result from HUB level 3 to MSFD broad habitat types using the translation matrix (Table 3).

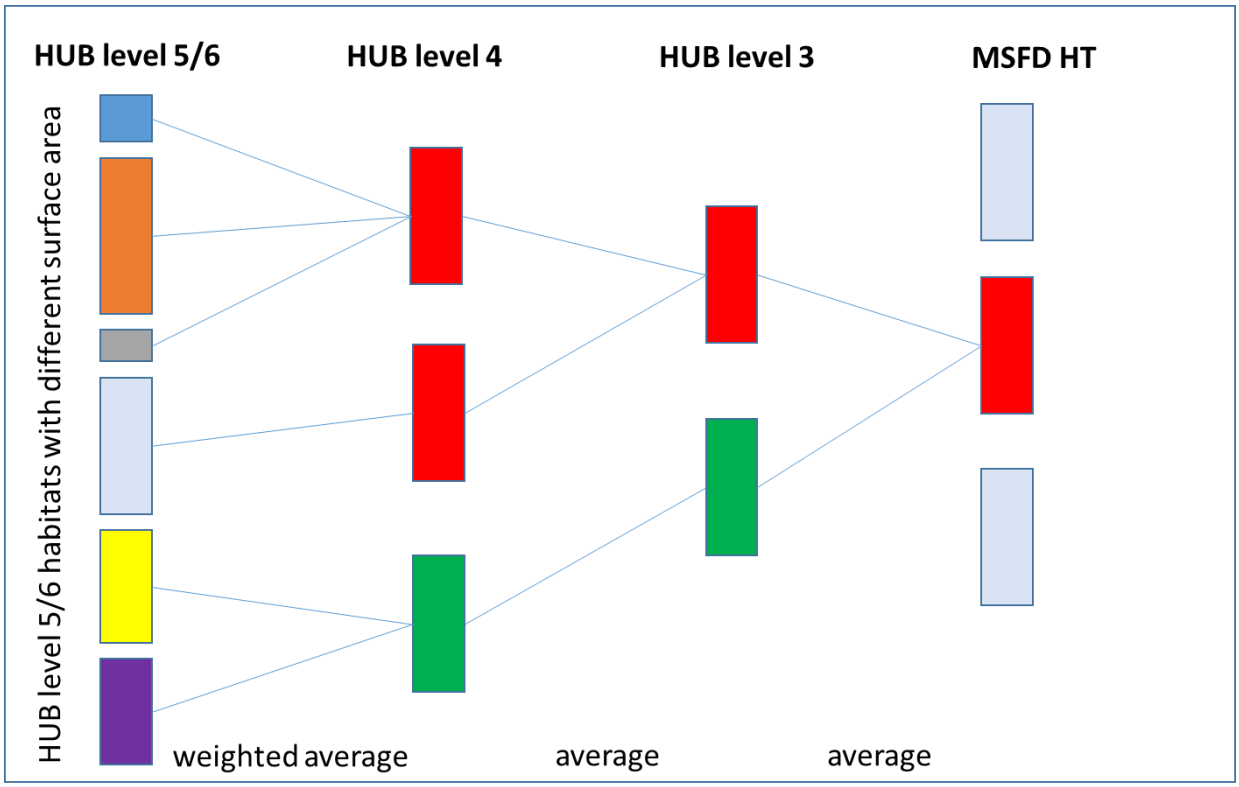

Figure 2. Aggregation principle according to option B (using all HUB level 5/6 habitats in the assessment unit).

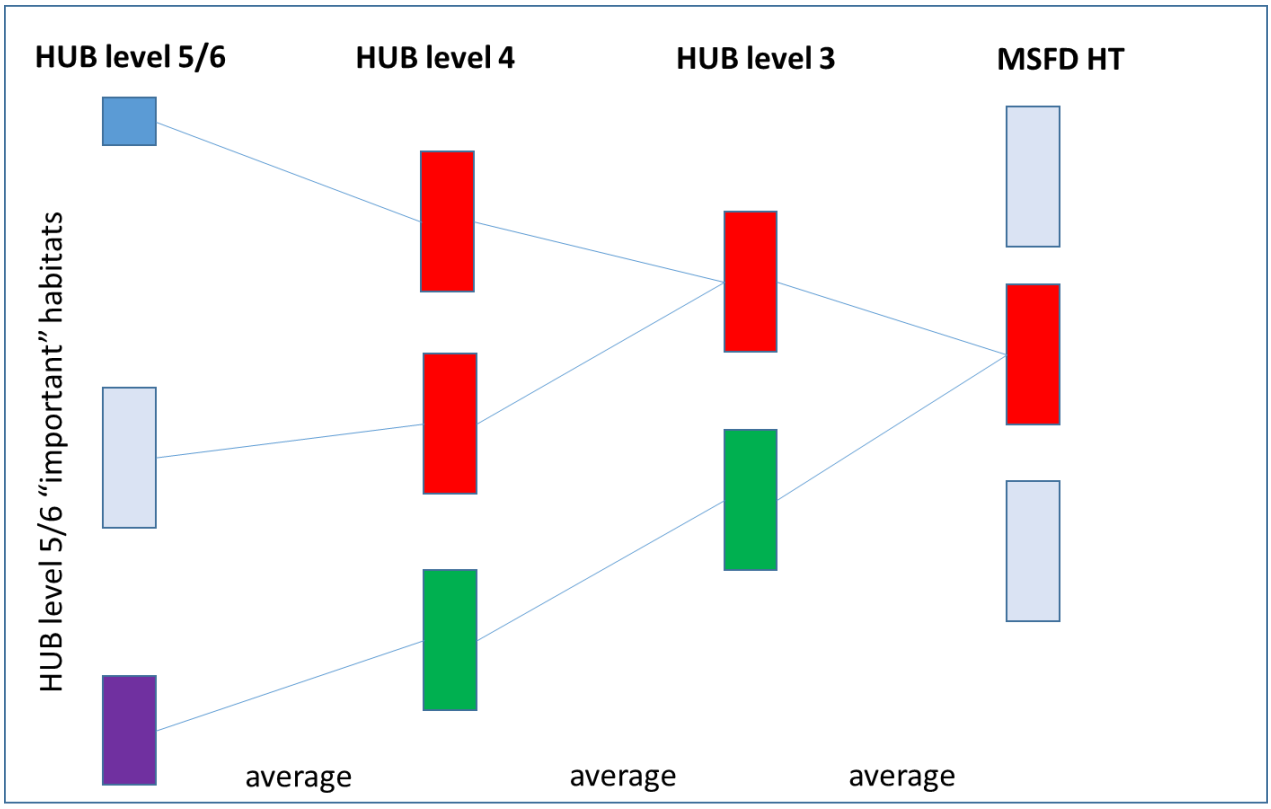

Figure 3. Aggregation principle using option A (using predefined list of „important" HUB level 5/6 habitats).

4. Threshold values

Under the MSFD the criteria for physical loss (D6C1) and physical disturbance (D6C2) do not have threshold values, but are instead used to support other criteria. D6C1 provides spatial information of habitat loss per habitat to D6C4 (habitat extent (loss)), and to D7C1 (spatial extent and distribution of permanent alteration of hydrographical conditions). D6C2 supports the assessment of impacts to broad habitat types under D6C3. D6C3 requires threshold values to define adverse effect per habitat type, and itself contributes to the assessment of D6C5, where also other adverse effects than physical disturbance are assessed (Walmsley *et al*. 2016). The threshold values to be set for adversely affected area relate to the threshold of a condition indicator, which defines at which point the habitat is considered to be 'adversely affected'. As such, the threshold values will be specific for each pressure and habitat and may vary depending on environmental characteristics of the assessment areas.

Building on the BalticBOOST literature review, but also carrying out specific pressure-state analyses, SPICE set out to compile information on possible habitat-specific thresholds. These were proposed in WP4 task 4.2.1 by using species-specific thresholds for concentrations of oxygen, hydrogen sulfide, nutrients and chlorophyll and also water transparency.

Based on the benthic species sensitivities to these stressors, SPICE WP4 provides a possible starting point for the assessment of adverse effects on HUB 6 benthic habitats. As the species information is linked to the most detailed habitat classification (HUB 6), the broader habitat assessments can be assessed by using the habitat status integration rules, as developed under the SPICE WP4 task 4.1.2 (see chapter 3.1).

To summarize the potential of this approach, Table 3 gives an example of how the frequency of habitat types for which pressure thresholds where compiled, i.e. the number (count) of level 6 HUB classification, serves

as a recommendation and highlights the suitability of individual habitat types for an assessment of benthic habitats. The example is based on oxygen and hydrosulphide concentrations (Table 4).

Table 4: HUB level classification where thresholds and ranges of oxygen concentration and hydrogen sulphide were documented having adverse effects on benthic species. Count numbers represent the number of times the respective habitat was suitable to be used for the assessment of adverse effects based on thresholds.

Level 3	count	Level 4	count	Level 5	count	Level 6	count
AA.A	8	AA.A1	8	AA.A1C	7	AA.A1C1	2
						AA.A1C2	1
						AA.A1C3	1
						AA.A1C4	2
						AA.A1C5	1
				AA.A1V	1		
AA.B	1	AA.B1	1	AA.B1V	1		
AA.H	20	AA.H1	1	AA.H1B	1	AA.H1B7	1
		AA.H3	19				
				AA.H3C	1	AA.H3C1	1
				AA.H3L	2	AA.H3L1	1
						AA.H3L8	1
				AA.H3M	12		
						AA.H3M3	6
				AA.H3N	3	AA.H3N1	1
						AA.H3N2	2
AA.I	2	AA.I1	1	AA.I1B	1	AA.I1B7	1
		AA.I2	1	AA.I2W	1		
AA.J	14						
		AA.J1	2				
				AA.J1B	1	AA.J1B7	1
		AA.J3	10	AA.J3L	6	AA.J3L1	1
						AA.J3L2	1
						AA.J3L4	1
						AA.J3L9	3
				AA.J3M	4	AA.J3M2	2
						AA.J3M4	2
AA.K	1						
AA.M	2	AA.M1	1	AA.M1B	1	AA.M1B7	1
		AA.M2	1	AA.M2W	1		
AB.A	2	AB.A1	1	AB.A1V	1		

		AB.A2	1	AB.A2T	1		
AB.H	10	AB.H3	10				
				AB.H3L	2	AB.H3L1	2
				AB.H3M	6		
						AB.H3M1	2
						AB.H3M3	2
				AB.H3N	1	AB.H3N1	1
AB.J	9	AB.J1	1				
		AB.J3	8	AB.J3L	4	AB.J3L1	1
						AB.J3L4	1
						AB.J3L9	2
				AB.J3M	2	AB.J3M4	2
				AB.J3N	2	AB.J3N1	2
AD.N	1	AD.N5	1				

5. Guidelines for assessments of benthic and pelagic habitats.

5.1 The general assessment framework

MSFD criteria D6C4 and D6C5 correspond to the 'range/area covered by habitat type within range' and 'specific structure and functions' criteria of the Habitats Directive (Directive 92/43/EEC), and information on these can be taken directly from the reporting for that Directive where it relates to habitat types selected for MSFD assessments.

The principle of the assessment system is therefore based on practices used for Habitat Directive (HD) reporting (Evans & Arvela 2011), taking the revised methodical guidelines of the MSFD into account. The assessment procedure is based on conditional classification of four different habitat properties, namely, **Area**, **Extent**, **Quality** and **Impact**. The assessment outcomes in HD are catalogued in one of three status classes, which can be interpreted as GES and subGES. To minimize the national differences caused by spatial sampling frequency and/or used modelling techniques, area and extent are evaluated in a grid. A similar approach was used for the HELCOM Red list assessment. A reasonable cell size for the grid should be discussed and agreed upon. The 20 km x 20 km was used in the Red list assessment, but the assessment of cumulative effects uses 1 km x 1 km and the habitat models even more detailed grids.

Area was defined as the sum of the grid squares where the habitat is found at present. The current spatial area may also be reduced by the physical loss of the habitat, if the assessment grid allows such a detailed calculation. The assessment is based on comparing the current state with a reference level. Historical data or current data combined with expert judgement may be used to define the reference level.

Extent is defined as area inside the shortest continuous boundary which connects the outer corners of the grids where the habitat is found at present. Also in this criterion the physical loss of the habitat will be calculated. This may change the outer boundary of the habitat type. Grids that occur only in unsuitable areas (e.g. terrestrial areas) will be excluded from the extent. The assessment is based on comparing of the current state with reference levels. Historical data or current data combined with expert judgement may be used to define the reference area. Under the MSFD, the extent of habitat loss is assessed under D6C3 and expressed as a proportion of the overall extent. The distribution of physical loss pressures is closely associated with the different activities causing the pressure (i.e. infrastructure developments on the coast or offshore, or man-made modifications to the coast or seabed such as land claim or coastal modifications). Mapping the distribution of the relevant activities can be used directly to prepare spatial data sets on the distribution of the physical losses per area. For coastal areas data should be available from WFD hydromorphology assessments.

Quality includes the assessment of structure and functions of the habitat, such as species composition or physical properties reflecting the quality of the habitat e.g. water transparency, presence of oxygen deficiency etc. This can also be defined as the state of a habitat and is directly related to the MSFD concept of 'adverse effect'. In SPICE, the assessment of quality may be based on the thresholds for adverse effects (WP 4.2.1). For a standardised approach a list of meaningful environmental variables/indices could be used and agreed upon beforehand. The proportion of the area or monitored stations in good status may also define the habitat quality. Similarly under the MSFD, quality of the habitat is assessed as the extent of the remaining habitat (i.e. after any habitat loss) which is in a good status (biotic and abiotic structure, and function).

Human **impact** (pressure) on the habitat, such as the cumulative impact on benthic habitat indicator, can be used as fourth component of the assessment system. The difference to the quality criterion is that the human impact (or pressure) is a more risk-based approach. It does not measure the habitat degradation by

using state indicators of the habitat (as in the quality criterion), but the risk that arises from the human activities, pressures and potential effects on the habitat. This may be especially applicable in cases where the pressure effects have not been quantitatively linked with the habitat quality.

Each of the criteria are assessed by one or several indicators for each of the habitats. The status of a criterion is determined based on percentage threshold values were derived from guidelines for HD (Evans & Arvela 2011). The decline of 10% of area/extent and 25% for quality as threshold value for worst condition is derived from evaluation matrix for habitat type in Annex E (Evan & Arvela, 2011). The rest of the threshold values were derived from examples provided in guidelines for HD (Evans & Arvela 2011). The indicator evaluation should be carried out in a coordinated manner for the assessment units that are shared by several countries, noting that there might be some issues of assessing quality if national approaches differ.

The lowest status class of the four criteria determines the quality of indicators following the one out all out principle of the MSFD (Table 5). Similarly, the lowest indicator result is used under one criterion, if several indicators are used.

Table 5: Proposal for overall assessment matrix and threshold values for the indicator (following TAPAS Theme 2, Deliverable 2)

Parameter	**Status**		
	GES	**sub-GES**	**non-GES**
Area	Stable or increasing	Decline <10%	Decline >10%
Extent	Stable or increasing	Decline <10%	Decline >10%
Quality*	≥90% of area or stations in good status	<90-75% of area or stations in good status	>25% of area or stations in bad status
Impact	≥90% of area above threshold	<90-75% of area above threshold	>25% of area below threshold
Overall assessment**	**All "green"**	**One or more "amber", but no "red"**	**One or more "red"**

* The indicator assessed to have worst status decides the quality of habitat when several indicators were used.
** The parameter assessed to have worst status decides the overall status.

The guidance on assessing impacts on benthic habitats under the MSFD state that the assessments are undertaken per habitat type in a given assessment area. After the outcome of TAPAS theme 2, deliverable 2, on benthic indicators with the proposal to use HUB level 3 for the Baltic wide assessments, while applying more detailed levels on sub-basin scales where possible, the following assessment scheme was proposed, also applicable to the HUB level 6 recommendation of SPICE WP 4.

5.2 Stepwise guideline for assessing impacts on lost, disturbed and adversely affected benthic and pelagic habitats.

The following stepwise assessment guideline for the assessment of lost, disturbed and adversely affected benthic and pelagic habitats focuses on the specific assessment of habitat 'quality' and habitat 'impact' as presented in the previous chapter.

The protocol is based on the SPICE advances but also utilizes the HELCOM's protocol for preparing pressure layers and assessing cumulative impacts (HELCOM 2017b).

DATA PREPARATIONS

1. **Define the assessment area.** This is a GIS (Geographical Information System) file in vector format of the area where the assessment is applied. The assessment of habitats being lost, disturbed or adversely affected should be made on a sub-basin scale, (i.e. *'subdivision of region or subregion, reflecting biogeographic differences in species composition of the broad habitat type'*), following the revised COM DEC on GES criteria. I.e. each region or subregion is divided into a set of subdivisions which reflect the main water masses that influence biogeographic (species composition) changes in habitats (this will typically be temperature and salinity driven changes in the sub(region) and lead to a small number of subdivisions only). A single set of subdivisions of each region or subregion should be used for the assessment of all habitat types (i.e. the scale of assessment is the same for every habitat type, and the individual habitat types are considered within each subdivision/assessment area). For Broad habitat types (as specified under the criteria elements to be assessed in the revised COM Dec) it should be noted that for the purposes of assessing the condition of broad habitat types (D6C5), particularly when using ground-truth sampling techniques, representative subtypes should be selected, according to the set of characteristics given in the revised COM DEC. Additional habitat types, which may include habitat types listed under the Habitats Directive or Regional Sea Conventions, may also be selected, for example in cases where the Member State considers the broad habitat types are not sufficiently detailed for their MSFD implementation needs. Where 'additional habitat types' are selected, it is recommended that these also be used as the representative subtypes needed for assessment of the broad habitat types, as this will minimise monitoring and assessment efforts (Walmsley *et al*. 2016).

2. **List and define human activities and pressures.** The state of benthic habitats may be adversely affected by several pressures, depending on the different activities and associated pressures in each region or subregion. All human activities and pressures of relevance for the assessment area need to be listed and organized to identify which activity is causing or contributing to which pressure.

   List and define ecosystem components. Include habitat types for the assessment area at a scale to capture relevant features. SPICE recommends using HUB level 6 for the assessment of adversely affected habitats, but the HUB level may depend on the type of habitat and the pressures it faces. The broad habitat types are needed for the EU MSFD assessment. The broader habitat assessments can be assessed by using the habitat status integration rules, as developed under the SPICE WP4 task 4.1.2.

3. **Define the time scale**. The assessment period is defined and this affects the data on human activities and pressures (as well as other indicator data). Appropriate time scales are needed to asses lost disturbed or adversely affected habitats. To asses lost habitats the time scale needs a reference condition of > 12 years (two reporting cycles). This means that the respective pressure layer must cover the 12 years backwards. To asses disturbed and adversely affected habitats it is important to consider the recovery time of the ecosystem component, where the longest defined

recovery period within all assessed ecosystem components of the assessed habitat defines the recovery baseline for other components that might recover comparably faster. Times scales should optimally be chosen in a manner that the possible impact of pressures can be detected before the presumable full recovery of the habitat after the impact, in order to not miss a potential warning. This becomes important when considering cumulative impacts with synergistic effects on ecosystem components within a habitat type, where recovery times might vary due to cumulative impacts.

4. **Collect spatial data sets based on steps 2 and 3.** The data must cover the entire assessment area. If this is not possible with pure empirical monitoring data, suitable model data should be used. In some cases, direct pressure data is not possible to collect and pressure data may need to be estimated from data on human activities associated with that pressure. The pressure data should be quantitative and preferably measured using the same metric. The ecosystem components can be represented either quantitatively or as presence/absence data.

5. **Prepare GIS files on the pressures and ecosystem components.** In the case that data sets on human activities are used to represent a pressure, the data files should consider especially how widely a pressure is likely to be distributed from the location of the activity, as was done in the HELCOM second holistic assessment of ecosystem health.

    a. to assess the extent of the pressure in general, the distance may be wider than when assessing the adversely affected habitats;

    b. to assess adversely affected habitats, the respective thresholds and impact ranges of the pressure on the specific habitat must be included. These thresholds are likely shorter than the ones used to define the 'physical disturbance' in the TAPAS project. Suggestions for a few pressures were made in the SPICE WP4 task 4.2.1 (see also step 9).

6. **Aggregate pressure data layers.** The pressures used in the assessment follow the EU MSFD Annex III (Anon. 2017). The assessment can be done two ways:

    a. define the pressures in association with the activity it is causing (if applicable). For example, *Physical disturbance by bottom trawling.* This approach is called 'pressure-by-activity' approach and it helps in linking the pressure back to its source.

    b. an alternative approach is to first prepare the pressure-by-activity layers and then aggregate those into so-called 'aggregated pressure layers'. For example, *Physical disturbance*. This helps in assessing the MSFD pressures and also reduces the complexity of the assessment. Both ways are applicable, but many of the thresholds are defined at the level of 'pressure by activity' (e.g. distance thresholds defined by SPICE task 4.2.1).

7. **Define the assessment unit based on the spatial resolution of the input data.** 'Assessment unit' means the spatial unit which is assessed within the 'assessment area'. Usually this is done by a grid approach, where the assessment units are squares of certain size. The choice of size depends on the input data. If the input data is coarse relative to the assessment unit size is used, this may over-estimate impacts. If the input data is detailed relative to the assessment unit size used, this may underestimate impacts. For example, a big assessment unit does not capture a small habitat area physically lost, which might affect the 'area' or 'extent' criteria of the assessment. Similarly, a habitat 'quality' or 'impact' may be underestimated if the distance for 'adverse effect' is short but the assessment unit much larger.

ASSESSMENT OF QUALITY

8. **Define thresholds for adversely affected habitats.**

    a. The thresholds can be estimated on the basis of status indicators (e.g. the GES threshold for condition of macrozoobenthos or macrophytes). The GES threshold is used to delineate the area where the habitat status is not adversely affected. This may require spatial modelling in order to extend the good status into the entire habitat area.

    b. The habitat quality may also be assessed from the pressure point of view by using the pressure layers and cutting those with the threshold for adverse effects (i.e. a specific pressure value). The pressure layers can be point source pressures (e.g. dredging), spatial pressures (e.g. bottom trawling fishery) or spatial chemical or physical parameters (e.g. nutrient or oxygen concentrations or underwater noise). Some thresholds have been suggested in the SPICE WP 4.2.1.

9. **Define distance thresholds for adverse effects for each pressure.** The distance thresholds define how widely the pressure causes adverse effects from its source. If the pressure layer is spatial by its nature, then this step is not applicable. This step is done when preparing the pressure layer (Step 4 b).

10. **Extent of adversely affected habitat area (for the habitat quality).** Calculate the habitat area under adverse effects by using those pressure values that exceed the threshold and extending it according to the distance thresholds. Overlay all the pressure layers. Currently, no synergistic or antagonistic effects are included in this step and the assessment is based on separate pressure layers only. In future, the adverse effect could be defined on the basis of cumulative effects.

ASSESSMENT OF IMPACT

11. **Define distance thresholds for the pressure.** The distance threshold is used to prepare the pressure layer in Step 4 a.

12. **Estimate the habitat and species sensitivity**. The sensitivity scores of each of the pressures can be estimated e.g. on the basis of an expert survey and/ or literature review (See HELCOM 2017b). These will be used in the cumulative effect assessment but they also contribute to the selection of appropriate pressures for each habitat.

13. **Select pressures for the habitat-specific assessments**. Based on the habitat sensitivity, select those pressures which likely affect the habitat.

14. **Calculate an impact index.** Cumulative impacts can be calculated to assess the risk for high impacts for a habitat. The Baltic Sea Impact Index (BSII) and its reduced version for the cumulative pressures (BSPI are described in (HELCOM 2017 b). Cumulative impacts can be estimated by three alternative methods in the EcoImpactMapper software (Stock 2016). The index outcome is a relative score, but there have been successful cases validating that with in situ impact studies (Halpern et al. 2008; Andersen et al. 2015). The validation seems to require regionally specific studies, but those can then fully link the index with the state of the seabed. In the assessment of habitats, the cumulative impacts are calculated for each habitat type, which means that all the ecosystem components in the tool must be linked to a specific habitat type. For example, the broad habitat 'Infralittoral sandy bottoms' is a layer in the tool, but the linked more specific layers can be 'Eelgrass meadows', 'Sandeel habitat' or '*Mya arenaria* dominated biotope'.

ASSESSMENT OUTCOMES

The habitat quality and impact are two of the four habitat assessment criteria. These two criteria can be measured separately but are also related to each other in the way that an impact is seen in the quality. If the pressure-state relationship has not been established, the impact criterion represents the risk for a deteriorated status. The habitat quality criterion is typically assessed by the means of status indicators. The assessment will therefore need to identify the extent of the area of each habitat type for which the indicators do not achieve the threshold values (Walmsley *et al.* 2016).

15. **Assessment of habitat quality.** The assessment output for adversely affected area is presented for each benthic broad habitat type, and additional habitat types, in each assessment area. The key output is the total area adversely affected. The method will also produce spatial maps of the adversely affected and non-affected habitat areas.

16. **Assessment of potential impacts for a habitat.** The risk for impacted habitat area is presented as the total area under high impacts. If the 'high impact' can be ground-truthed anyhow, the impact assessment becomes more realistic and is closer to the assessment of habitat quality. Spatial maps of the impacted habitat area is also produced from the tool.

6. Recommendations from SPICE task 4.2.1

Supporting information for the further development of habitat assessments following observations made in SPICE task 4.2.1 are to:

- Limit the analysis to similar environmental conditions or take those into the model.
- Analyse the pressure responses with spatially and temporally limited data and ensure that the pressure and status data meet within the recovery time in order to see any effects.
- Ensure that the data set is suitable for the analysis. All non-dated pressure or status data causes possible noise in the results.
- Use literature evidence for the effects on sensitive species and their recovery times and model the effect.

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