Document title	The assessment of benthic habitats
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Background

The HOLAS III assessment follows a structure which aims to ensure robust results and traceability across the several steps which are integral to a usable holistic approach. Each of the steps of the process represents a progressively more integrated assessment result, eventually culminating in the holistic assessment report State of the Baltic Sea (see Figure 1 for a conceptual overview). This document presents the plan for assessment of benthic habitats, which builds on the relevant indicator reports and in turn constitutes a chapter in the Thematic assessment report on Biodiversity (red highlight in Figure 1 indicates which step in the process is addressed by the content of this document).

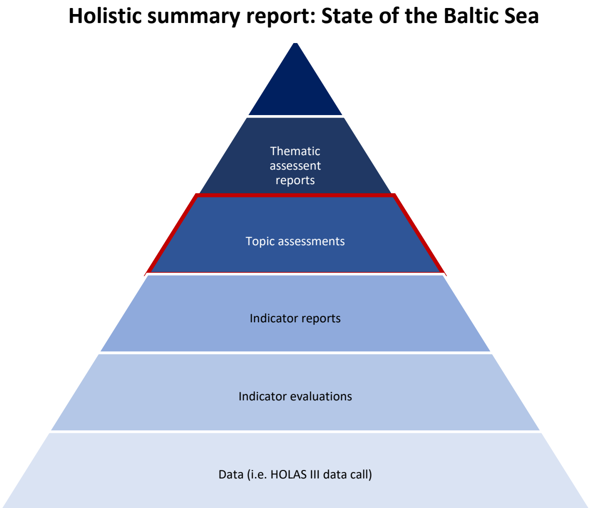


Figure 1. Conceptual overview of the HOLAS III assessment structure and the progressive integration of results.

This document contains an overview of indicator components related to benthic habitats and addresses the utilization of these in HOLAS III. The overview considers how the separate components are compiled and combined and could represent the assessment of benthic habitats in HOLAS III, for example how the indicator evaluations form the basis of the indicator reports, which, supported by scientific contextual information asses a topic (Topic Assessment) that is then included in a Thematic assessment (e.g. Biodiversity). The above conceptual overview outlines the general flow of information within this process and the segment identified in red is the focus of this document.

Action requested

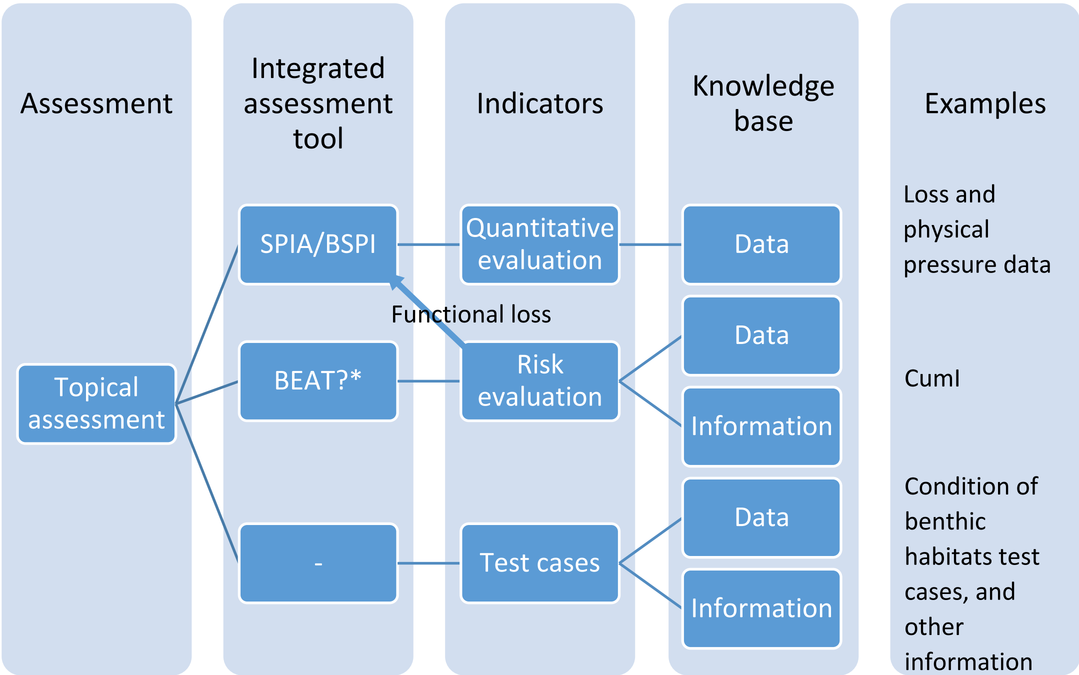
The Meeting is invited to consider and endorse the proposed approach for assessing benthic habitats in the HOLAS III assessment.

The assessment of benthic habitats

The assessment of benthic habitats in HOLAS III will consist of several separate components that are integrated/aggregated to provide the best possible overview of current knowledge, and allowing for progress made in other relevant ongoing processes (e.g. EU TG Seabed).

The component parts that will support the assessment of benthic habitats include: physical pressure data layers, data layers related to loss, the Cumulative impact of benthic biotopes (CumI) indicator evaluation (see document 3J-23 to this meeting), the information related to expected functional loss derived from CumI, test assessments carried out via adaptation of the Condition of benthic habitats indicator (see document 3J-25 to this meeting), the incorporation of the State of the soft-bottom macrofauna community indicator (see document 3J-24 to this meeting) under BEAT and/or the Condition of benthic habitats channels. The input of indicator leads and the EN BENTHIC group will be critical in forming the overall assessment within HOLAS III.

The figure below aims to summarise the approach, though the component parts may also be influenced by decisions made on these individual parts, (as represented in the documents addressing those specific component parts).



*Note: the issues related to the BEAT assessment (e.g. what components to include, how to include CumI, etc) are addressed in document 3J-48 to this meeting and the issue is not duplicated in this document. The issue of addressing benthic habitats is therefore reflected only in simple terms within this document and in the case illustrated above should CumI not enter BEAT (or even if it did) it would also likely be a valid direct input to the Topical assessment.

Indicators anticipated or available for HOLAS III

The following indicators will be (or are expected to be) available for HOLAS III.

- Cumulative impact of benthic biotopes (CumI) indicator (see document 3J-23 to this meeting)
- State of the soft-bottom macrofauna community indicator (see document 3J-24 to this meeting)
- Condition of benthic habitats indicator (see document 3J-25 to this meeting), potential test cases

Inclusion of the indicators in the integrated biodiversity assessment (BEAT)

The appropriate approach to address benthic habitats in HOLAS III using the BEAT integrated biodiversity assessment are the subject of document 3J-48 to this meeting. The current proposals explore developments from HOLAS II, such as the potential inclusion of CumI and the adaptation to address Benthic Broad Habitat Types (BHTs) directly.

Summarising loss and physical disturbance

Data layers relating to physical disturbance and loss are commonly used in other assessments also, for example under the Baltic Sea Pressure Index (BSPI), and as under further development in the Spatial Pressure and Impact Assessment (SPIA) tool. Effort has been made to harmonise the data layers entering these related assessment strands.

To summarise physical disturbance and loss (e.g. under EU MSFD D6C1 and C2) the following is envisaged. Loss data layers will be derived from relevant construction etc activities reported to existing HELCOM databases (as addressed in the HOLAS III data call) and similarly data layers from physical pressure will also be compiled. The data layers related to physical pressures will also represent the data entering the CumI indicator evaluation. In addition, as part of the CumI evaluation the element of 'functional loss' is also derived (i.e. within the cumulation matrix where the intensity or frequency of pressures result in such high levels that expected loss of functionality is identified) and this will be summarised as a component of the loss evaluation.

Condition of benthic habitats

The condition of benthic habitats indicator will be adapted to align with the recent proposal developed for assessing the condition of benthic habitats aligned with work ongoing at EU TG Seabed. A version of this proposal was presented at EN BENTHIC 7-2021 (document 4-2) and an updated draft version that has recently been submitted to EU TG Seabed 7-2021 is provided as an annex to this document (see below). The general structure of the existing Condition of benthic habitats HELCOM indicator applies a similar logic and adaptation to evaluate the recent proposal and its functionality, aiming to carry out test cases by HOLAS III. These test cases would them be applied as supporting contextual information in the HOLAS III topic assessment (within the thematic assessment of biodiversity). Where possible in these test cases the relevant components of the State of the soft-bottom macrofauna, CumI and other relevant state components (e.g. oxygen) would be included.

Additional information

The above indicators alone, and their integration via BEAT or the test cases targeted under the Condition of benthic habitats indicator, do not provide a complete and comprehensive overview of the status of benthic habitats – in particular outside of data-rich test case study areas. It will therefore be critical to include other supporting contextual scientific information in the designated section ('topical assessment') for benthic habitats within the HOLAS III Thematic Assessment of Biodiversity. This information may for example rely on peer reviewed scientific publications, and national or regional reports. Other data sources and relevant indicator assessments not directly assessing benthic habitats but of clear relevance will also be incorporated where available (e.g. oxygen or status of hard substrate species). Inclusion of relevant factors within the thematic assessment report will provide context to existing regional assessments and also complement those assessments where gaps exist.

Overall summary of benthic habitats

he overall assessment of benthic habitats in HOLAS III will focus on the existing and operational components described above (e.g. data layers for loss and physical pressures, the risk assessment offered by CumI, and other relevant state components such as the state of the soft-bottom macrofauna community and oxygen). Where integration under the BEAT tool is viable this will also contribute. Test cases for other approaches (e.g. the Condition of benthic habitats) and the inclusion of other relevant supporting contextual information (e.g. published reports and papers), supported by the input of regional experts, will aim to summarise the state of benthic habitats in areas where a full assessment is not possible at this stage.

Annex 1: Draft approach for addressing the Condition of benthic habitats as prepared for EU TG Seabed 7-2021.

The draft proposal developed for assessing the condition of benthic habitats provided below builds on work presented previously and is aligned with work ongoing at EU TG Seabed. An earlier version of this proposal was presented at EN BENTHIC 7-2021 (document 4-2), and this draft proposal provides a clearer structure to the concepts outlined under State and Conservation 14-2021 document 4J-70 Rev.1. The proposal is applicable for both the BSAP and MSFD and the text below represents an updated draft version that has recently been submitted to EU TG Seabed 7-2021.

Aggregation and integration of spatial assessments of D6C5

Text is meant to the TG Seabed Art 8 guidance report (the 'long version'. It is prepared by Antonia Sandman, Owen Rowe, Samuli Korpinen and Sander Wijnhoven based on a HELCOM meeting document and an earlier version of the assessment scales document.

According to the Commission Decision (EC 2017/848), status of benthic habitats (D6C5) is defined as "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."

For assessment of D6C5, adverse effects from all pressures shall be accounted for, including adverse effects from physical disturbance (D6C3) and from pressures under other descriptors such as non-indigenous species (D2), populations of commercial fish and shellfish (D3), eutrophication (D5), hydrographical changes (D7) and contaminants (D8), as well as habitat loss (D6C4). **However, the focus is not on pressures but in their impacts as seen in the alteration of state**.

The aim of this section is to provide conceptual guidance on how to integrate different types of indicators and assessments into extent of adverse effects according to D6C5. The broad concept behind the proposed structure is that where suitable and appropriately designed monitoring data exist at the appropriate scale, this provides the strongest weighting to the overall assessment of D6C5 (i.e. the assessment of structure and function of benthic habitats), and where such data (to directly address D6C5) do not exist the assessment is supported by a combination of state indicators under other descriptors or policies, and/or risk based methods (such as applied under D6C3) and/or pressure based evaluation (such as pressure information under D6C2) that may be relevant and offer the possibility to infer an indication of overall benthic habitat status. The physical loss (D6C1/C4) would be incorporated as a final overlay to the above approach.

The concept of the assessment is visualized in Figure 1 for three broad habitat types (BHT) each using a different set of assessment data. The concept is based on prioritization of the assessment data in the following order:

(1) benthic state indicators representing a BHT;
(2) state of other descriptor criteria relevant for a BHT;
(3) predictions by impact models based on pressures and sensitivities (e .g. D6C3); and
(4) risks for impacts by pressures and/or human activities.

In addition, physical loss for the specific BHT (D6C4) is always added to the assessment.

The assessment uses the data types according to the priority order and estimates the representativity and sufficiency of each data type before deciding whether another data type is needed. For instance, in Figure 1 it is shown that the assessment of BHT1 was based on benthic state data and the results of other descriptor criteria (as required by COM DEC), whereas BHT2 required also pressure-based data types. In practice, it is assumed that all data types will be used for the assessment (but also in those cases the priority order of data, as presented above, will apply). It is furthermore noted this approach leaves flexibility for member states or regions to develop more detailed methods to carry out the assessment.

Integration rules: This report leaves it open how the different data types are integrated in the spatially overlapping areas. The example below suggests weighted averaging (based on relevance of the result for the BHT). This would require numeric interpretation of the state (or risks for the state; e. g. HELCOM BSII tools). Also, other approaches can be used, such as matrices of impact categories (e. g. the HELCOM CumI and the OSPAR BH3). Another integration step is needed when the overall BHT status is estimated. This could be calculated as area-based averaging.

Determination of the sufficiency of the data layers is based on their key role in this assessment. It is used to select the data layers for the assessment. The sufficiency should be defined by:

(i) Representativity, i.e. how well the data layer addresses the state of the BHT (or other habitat). For example, an indicator of macroalgae depth limit is used for the infralittoral hard bottom but if it uses only one algal species, it may be estimated as not sufficient to determine the state of the habitat alone in that locality.

(ii) Sufficiency of monitoring data, i.e. is the monitoring effort sufficient for the assessment?

(iii) Confidence, i.e. is the data layer of good quality. This may include quality issues with data accuracy, expert judgement or uncertainty in recovery. If confidence of a data layer is estimated as being low, one should proceed to the next step in the process (see below) and use alternative/additional data.

(iv) Spatial coverage: there may be uncertainties in the extent of the impact (e. g. sediment plumes) or spatial accuracy of the impact (e. g. bottom-trawling tracks), and one should add other data layers. This applies to both a gridded approach and to a non-gridded approach.

The assessment process is further described by eight steps (below) for an example case where circalittoral sand and circalittoral mud are assessed, assuming infauna and epifauna being the major subtypes of biota within those habitats (Figure 5 and steps 1-8).

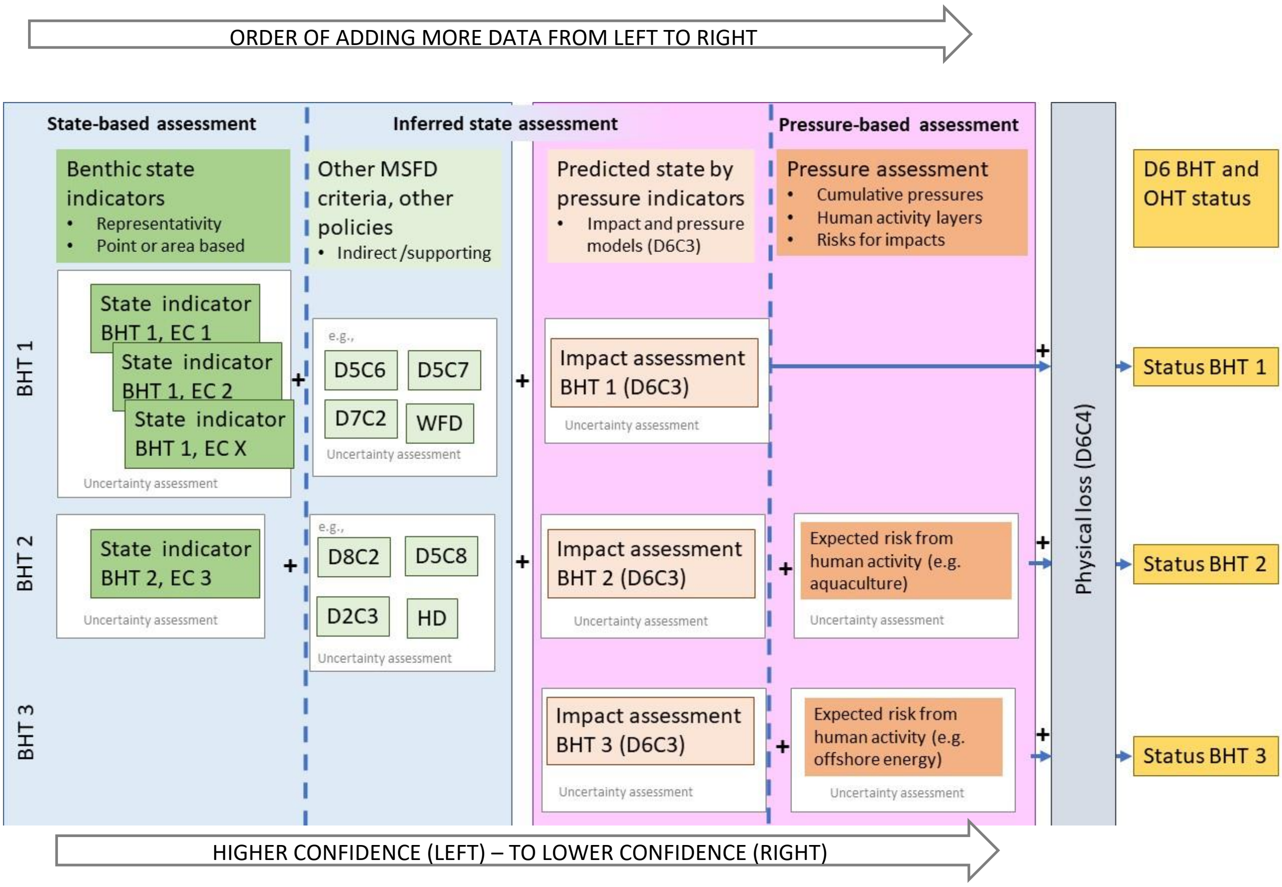


Figure 1. *D6C5 Assessment hierarchy within assessment units. The concept figure shows four types of data to the D6C5 assessment (top row) for broad habitat types (BHT; left side). BHT1 is based on benthic state indicators and other relevant MSFD criteria (incl. D6C3 which is based on inferred state by predicted impacts and WFD results). Within the BHT1 state assessment, different ecosystem conditions (EC=Ecosystem Components; e. g. indicators or sub-habitats) are integrated. BHT2 is based also on pressure-based assessment of risks from other pressures, and BHT3 does not have benthic state indicators (or other criteria results) but all the other types of data. Physical loss (D6C4) is shown separately as it is not part of the data prioritization, but always added. The hierarchy does not require a gridded approach as the spatial data can be overlaid by GIS, but if a gridded approach is used, the above model should apply to a grid cell.*

D6C5 assessment steps

An example of the D6C5 assessment is given by eight steps and it is based on Figure 1 (the concept) and Figure 2 (example).

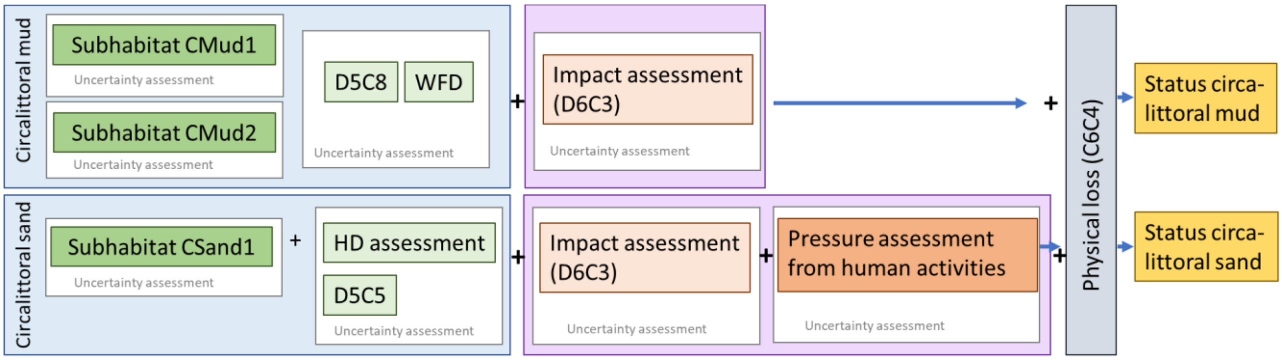


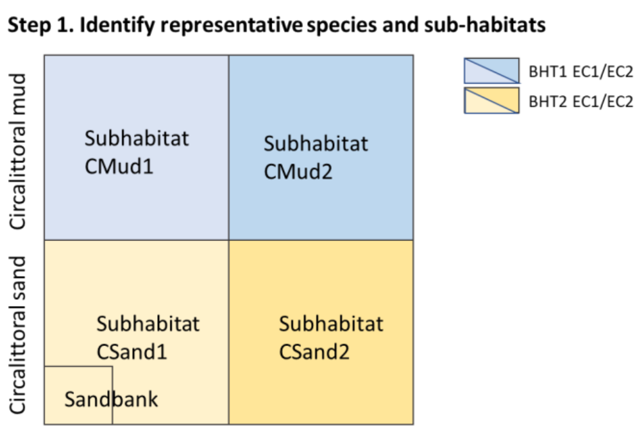
Figure 2. *Assessment example for the BHTs circalittoral sand and circalittoral mud. The figure follows the logic of Figure 1 and is further explained in Steps 1-8 below.*

Step 1. Identify relevant and representative species and sub-habitats

As the broad habitat types are very general and can contain a multitude of biotopes, and since monitoring is generally directed towards biological components or functions, it is therefore critical that the sub-habitats representative of the defined BHTs are identified at an early stage of the process. According to the GES Decision, the selection of sub-habitats (and species) to be assigned to the benthic broad habitat types are based on scientific criteria and ecological relevance. In addition (but not overriding the scientific criteria) practical criteria such as data availability could be considered, though exclusion of components should be reflected in the assessment and would be expected to influence the confidence in the assessment.

A list of relevant species or biotopes representative of each BHT is produced. The list should cover as many ecological and functional aspects of the BHT as possible, equivalent to EUNIS level 4 or finer, and possibly focusing to most sensitive features. Subtypes are to be identified unconditionally, but should, as far as possible, cover relevant pressures according to known pressure-response relationships. However, in practice priority, would be given to subtypes subject to monitoring or with good data availability.

In the example, the area of Circalittoral mud and the area of Circalittoral sand were both divided to two sub-habitats (here with equal areas, as represented by similar-sized boxes).



Step 1 notes: The two BHTs were divided to two sub-habitats, representing different ecological features and monitoring data. These are not named here but could represent EUNIS 5 habitats. In addition, it was noted that the Habitats Directive 'Sand bank' exist in the area.

Confidence/sufficiency to be considered:

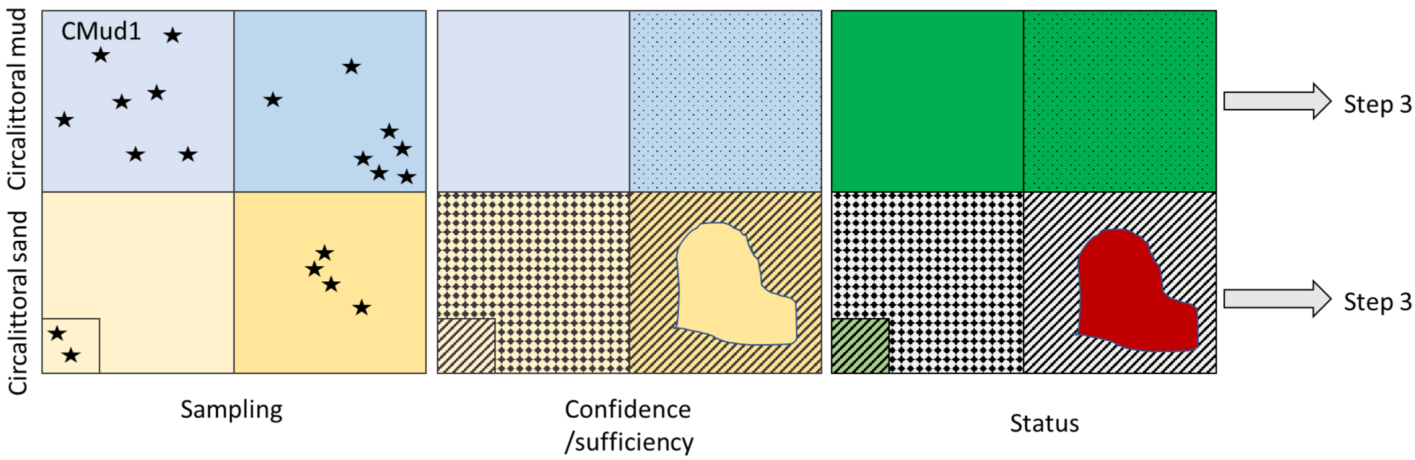
- *Does the list cover enough subtypes to be representative?*
- *Are all key pressures represented?*
- *Do the sub-habitats cover all major organism groups and functions?*

Step 2. Assessment and aggregation of subtypes based on monitoring data

Once the list is established, **existing monitoring data and status indicators are linked to the subtypes**. If those exist, a preliminary status assessment of the subtypes is made, and aggregated to BHT level (method not agreed in TG Seabed, but examples exist, e.g. https://helcom.fi/wp-content/uploads/2020/04/Theme-4_Deliverable-4.1.2.pdf).

Evaluation of sufficiency and representativity is made to judge whether more data types are required to assess the BHT in that assessment unit. Figure below shows how different confidence is given to the sub-habitat monitoring results. For Circalittoral mud, the data was estimated as sufficient and this assessment step concluded good state, whereas for Circalittoral sand only parts of the area were given a status result. As the GES Decision requires including also other descriptor criteria, oth the BHTs will move to Step 3. See the figure notes for more explanation.

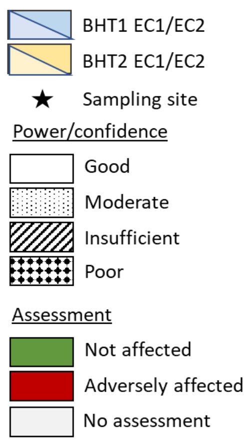
Step 2. Assessment and aggregation of subtypes based on monitoring data



Step 2 notes: State results from sampling are assigned to the BHT sub-habitats (stars in left panels). The sampling results for CMud1 and CMud2 areas indicate good state for the entire area and confidence of the Cmud1 is good but for the CMud2 assessment the confidence is only moderate (middle panels). These resulted in good state (right panels). For the Circalittoral sand, the sampling results suggest good state for CSand1 and adverse effects for CSand2 area, but the confidences are poor and insufficient (spatially limited sampling). Hence, the state results for Circalittoral sand sub-habitats are considered insufficient and cover only parts of the BHT area. As also other descriptor criteria need to be included, both the BHTs move to Step 3.

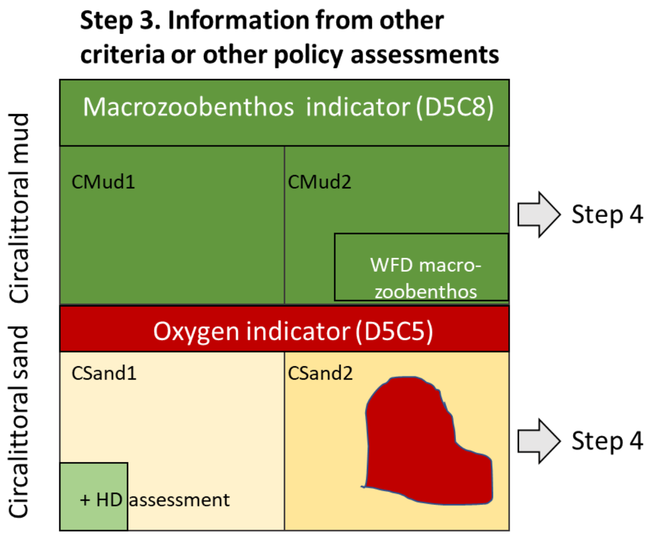
Confidence/sufficiency to be considered:

- *Are state results representative for the assessment unit?*
- *Sufficient pressure-response relationships?*
- *Is the spatial and temporal data sufficient?*
- *Is the monitoring method representative?*



Step 3. Information from other assessments (inferred by additional status indicators)

Assessments from the other MSFD descriptors, the EU Water Framework Directive (WFD) and the EU Habitats Directive (HD) are added to the assessment. Also, these results can be assigned to the smallest possible assessment unit such as sub-habitat, because that increases accuracy of the assessment. The results from Step 2 are integrated with the new ones where they overlap. The method for this integration needs development, but weighted averaging may be used where the weights can be determined based on the relevance of the result for the assessed habitat type (may require expert judgement). For areas where no previous result was available, only the new results are used.



Step 3 notes: Inclusion of macrozoobenthic results (WFD and D5C8) to Circalittoral mud did not change the conclusion; the state is still good. For Circalittoral sand, the D5C5 results (poor state, red) as well as the Habitats Directive full assessment result for 'Sandbanks' (good state, green) are integrated into the two sub-habitats Csand1 and CSand2 assessment of Step 2. The D5C5 result does not overlap previous results (and is used directly) but the Sandbank assessment is integrated with the Step2 results. The new results cover only partly the Circalittoral sand area and hence were estimated as not sufficient (confidence assessment not shown here). Both the BHTgo to Step 4 for inclusion of D6C3.

Confidence/sufficiency issues:

- *Relevance to benthic habitats?*
- *Confidence integration rules.*

Step 4. Spatial estimates of adverse effects, D6C3

Assessment of D6C3, extent of habitats adversely affected by physical disturbance, is added. In principle the D6C3 models could be validated to the level that they could be used already in the steps above, but the current models are indicating 'potential impacts' or 'risks for impacts', because they do not use state-derived thresholds for adversely affected habitats. Nonetheless, as spatial interpolations, they have likely a major role in the D6C5 assessments.

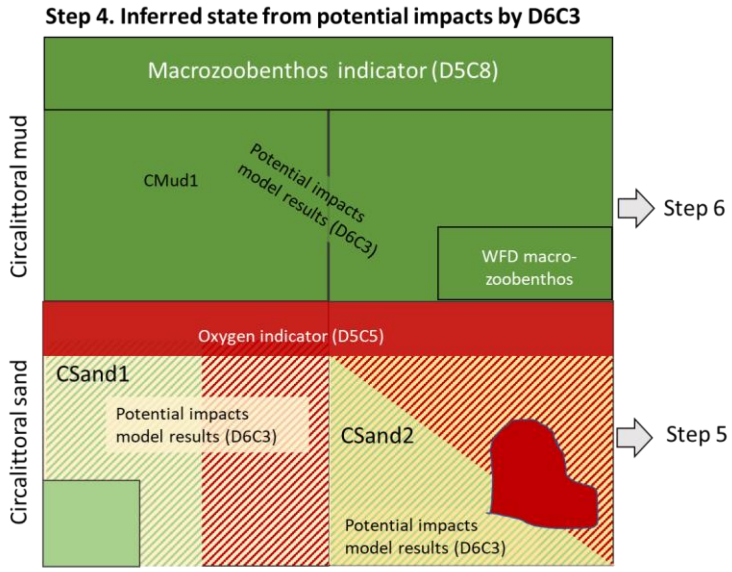
To assess risk of impact from physical pressures, various models addressing the potential impact of pressure (derived from human activities) could be applied (see Appendix 1 for ICES models). This step would utilize data layer(s) of physical pressures and, by adding various estimations of species and habitats vulnerabilities, would derive an expected impact (i. e. a form of risk assessment based on known activities and pressures). Confidence of the impact maps could be assessed by comparison with data on status indicators and based on other relevant spatial and temporal data input factors.

The risk of underestimating the impact may take place if what is sensitive is already lost. Overlaying pressures with sensitivity scores to achieve impact assumes that the sensitive components are still available. Therefore, the pressure layers and the impact layers should be correlated. High pressures in areas with low impact could indicate that sensitive (sub-)habitats have already been lost.

There is also the risk of overestimating the impact as the pressure data over the 6-year assessment period may overlook the ecosystem recovery between the pressure events.

The results of this step will be integrated with all the previous results:

(1) in overlapping areas weighted averaging is used to integrate the results (the weights determined on the basis of the relevance of the indicator/data for the BHT);
(2) in non-overlapping areas, the impact model results are taken directly.



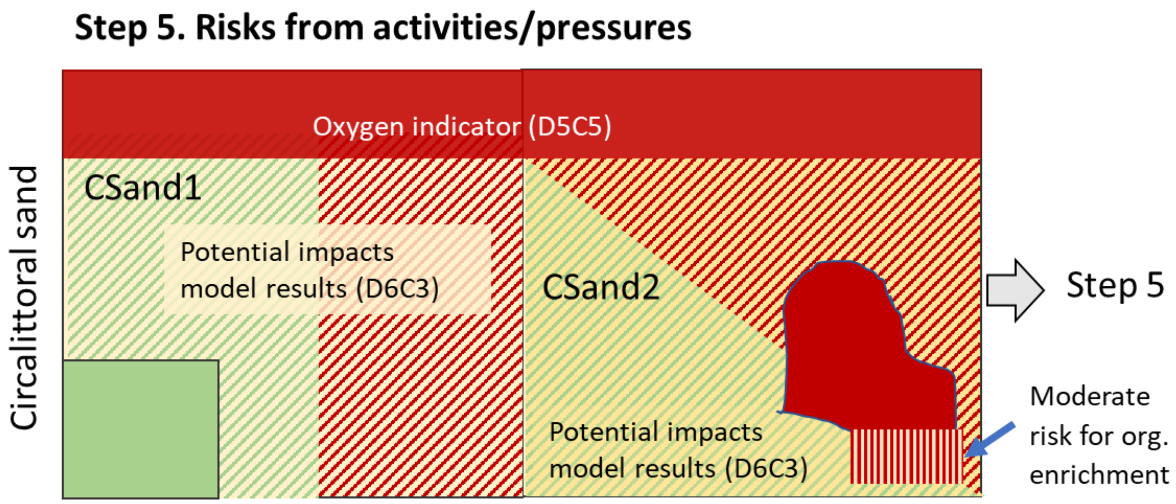
Step 4 notes: The model predicting the area of potential impacts from physical disturbance (D6C3) was integrated to the assessments of both the BHT. In Circalittoral mud the results indicated no adverse effects. While the model results do not have full confidence, they are not contradictory and hence the conclusion for good state prevails. In Circalittoral sand, the D6C3 results are visualized as striped area indicating insufficient confidence to indicate that this model includes only some pressure impacts. The model covered the entire BHT area and hence overlapping results are integrated with the existing results.
As other pressures than physical disturbance may impact Circalittoral sand, the sufficiency evaluation proposed to move to Step 5.
Confidence/sufficiency issues:

- *Spatial accuracy/confidence of habitat and pressure maps.*
- *Quantification of pressure/response relationships and threshold values for adverse effects.*
- *Confidence integration rules.*

Step 5. Risks from activities/pressures

If the impact model is not available or it was considered not sufficient, the information on activities and/or pressures potentially impacting the benthic habitats is added directly as a risk-based layer that would highlight points/areas where there are risks of impacts.

Under Step 5, identify which pressure impacts have not yet been utilized in the previous steps. These may include, e. g. pressures covered by other descriptors but where criteria results were not available, or pressures not sufficiently covered by other criteria (e. g. organic enrichment from aquaculture). Consider and record the risk for adverse effect for each case separately, but do not overestimate the impact area. Note also that low risks for adverse effects should not lead to adverse effect result.

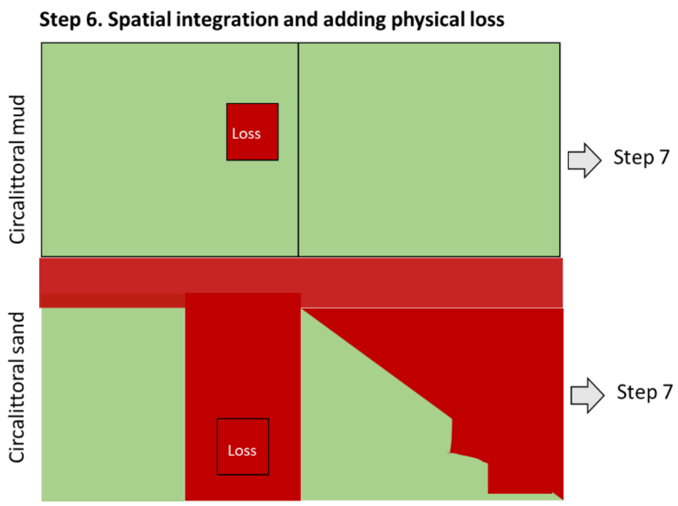


Step 5 notes: It was identified that impacts from organic enrichment had not been covered by the previous steps for Circalittoral sand. This layer was added to the BHT (indicating moderate risk for adverse effects) and integrated with the overlapping results.

Confidence/sufficiency issues:
- *Quantification of activity/pressure and pressure/response relationships*
- *Spatial accuracy/confidence of activity and pressure maps*

Step 6. Addition of physical loss

Include data on **physical loss** which conforms to the D6C1/C4 requirements. A physical loss of a habitat in an area automatically means that a good state cannot be evaluated for that area.



Step 6 notes: Spatial integration of the overlaid results will be made. This results in status results for the two BHTs.

Area estimated as physically lost per BHT (D6C4) is added to both the assessments. This area is directly assessed as adversely affected.

Confidence/sufficiency issues:
- *Spatial accuracy of the D6C4 extent.*

Step7. Overall status (D6C5)

After all the six steps, spatial data is laid over the assessment area of a BHT. As indicated above in steps 1-6, there is a priority order which of the layers are used for assessment of the extent to which GES is achieved. Each step forward is taken, if the sufficiency of the assessment result is questioned. However, the steps 2-4 should always be taken because the GES Decision requires other criteria to be “taken into account”. As the basic principle is that state results are more informative of the adverse effects than pressure-based results, the Steps 3 and 4 can be given less weight, if the sufficiency analysis indicates that.

Each data layer will reflect the state of the habitat. In order to integrate several layers, also risk-based assessments need to be interpreted on a state scale and semi-quantitative result need to be integrated.

As a result of the sufficiency estimation, there will be selected data layers over the assessment area and they will overlap, either in a grid cell or without the grid. The state of a BHT in a cell or spatial point is determined by an **integration rule**. Some integration rules were suggested in the beginning of the D6C5 section. As the data layers have varying priority ranking (e. g. state results are prioritized over risk-based ones), the data layers will have different weightings and the overall result could be determined as a weighted mean of all the results. Varying criteria can be developed to determine these weights or other integration rules.

The final assessment is given for each BHT within each MRU where they are found. The assessment is given as a % and km^2 of the BHT (within MRU) in GES. Additionally, similar status results can be given for the other habitats and sub-habitats within BHTs. The presentation of results is however discussed in the Article 8 guidance document (once available).

Step 8: Addressing natural conditions and historic factors

Differences in the definition of “good status” due to the natural environment should be reflected in the biological status indicators used in the assessment. However, an assessment mainly based on pressure indicators might overlook natural conditions. Thus, the final assessment might need to be adjusted with respect of gradients in e. g. salinity or wave exposure. Where information or data are available to indicate historic ranges of habitat type or historic biotic consortia that are no longer present this should be reflected. If this aspect is not built into threshold values, then spatial extent aspects should be represented and referenced to show spatially on the assessment concluded above where larger uncertainty may exist in achieving natural states.

Appendix 1. ICES models to predict impacts from physical disturbance (D6C3) and benthic pressures

Methods to estimate impact

Population dynamic (PD) approach	Quantifies the benthic community biomass relative to its' carrying capacity based on trawling intensity, the penetration depth of trawl gears and the recovery rate of benthic organisms
Longevity (L1) approach	Quantifies the community biomass of benthic organisms that are affected by trawling during their life span

Impact indicators

Impact indicators	Method	Short description
1 – Impact	PD and L1	Annual average fishing impact across grid cells in an area.
2 – Area below impact threshold	PD and L1	The proportion of grid cells with an impact below a (chosen) impact threshold in an area

Pressure indicators

Annual pressure indicator	Description	Notes
1 – Intensity	Average number of times the area is swept by bottom-contacting fishing gears. Estimated as the sum of swept area for all vessels using bottom-contacting gears or by métier divided by the total area of the considered area (regional/ subregional sea, or broadscale habitat type within that sea).	'Swept area' is an estimate of the area of seabed in contact with the fishing gear and is a function of gear width, vessel speed, and fishing effort. This indicator is a proxy of the number of times the area is swept.
2 – Proportion of grid cells fished	The number of grid cells (c-squares) fished at least once (irrespective of the swept area within the cell), divided by the total number of grid cells (c-squares) within the considered area.	
3 – Proportion of area fished	The sum of swept area across all grid cells in a considered area, where swept area in a specific grid cell cannot be greater than the area of that grid cell, divided by the summed area of all grid cells.	This indicator provides the best estimate of the proportion of area fished.
4 – Aggregation of fishing pressure	The smallest proportion of the grid cells (c-squares) where 90% of the total swept area occurs.	
Multiple year indicator	Description	
5 – Persistently unfished areas	In order to understand the length of time that grid cells remain unfished, Indicator 2 could be evaluated over six years.	