THEME 3: Physical loss and damage to seabed habitats

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WP 3.1 Deliverable 2: Guidelines for setting environmental targets for benthic habitats

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1. Introduction: Why are environmental targets necessary for benthic habitat?

Good environmental status of benthic habitats is a prerequisite for marine life as most of the marine species are either directly or indirectly linked to it and many spend at least part of their life history on or in the seabed. Benthic habitats are also under increasing utilization due to their rich abiotic and biotic resources. As the impacts on the seabed are not visible to our eyes, it is necessary that monitoring and assessment methods are quickly developed and regulatory mechanisms established to avoid any unwanted ecological and economic crises.

HELCOM has developed core indicators that reflects the state of the seabed habitats in terms of the condition of benthic communities ('State of the soft-bottom macrofauna community') as well as an indicator reflecting the 'Cumulative impacts on benthic biotopes'. In addition, an indicator is being developed to assess the condition of benthic habitats. These two state indicators can be used to assess good environmental status (GES) according to the EU Marine Strategy Framework Directive (MSFD). The cumulative impacts indicator measures impacts of anthropogenic pressures on benthic habitats and can be used as an indirect indicator for GES assessment. The draft revision of the Commission Decision 2010/477/EU on criteria and methodological standards on good environmental status (GES) of marine waters (hereafter 'revised COM DEC') has a specific focus on impacts of anthropogenic pressures on benthic habitats. While methods for estimating the impacts exist (e.g. Korpinen et al. 2013), there are no methods available to set any thresholds to define whether GES can be achieved or not. Common approaches to threshold setting have, however, been discussed in the reports of the HELCOM CORESET and TARGREV projects (HELCOM 2013 a, b).

According to the MSFD, reduction of anthropogenic pressures are set and assessed under Article 10 and these are called environmental targets. Environmental targets are defined in the directive as 'to guide progress towards achieving GES' and Annex IV of the MSFD gives further details. The cross-cutting issues document prepared by DG Environment[1] makes the following clarification: 'Art. 10 – environmental targets should focus on the predominant pressures identified on the basis of the initial assessment made under Article 8, identifying the reductions in their intensity, frequency or extent that are needed to achieve GES'.

Figure 1 shows how the environmental targets are understood in this report. The level of pressure that is consistent with GES is expressed as *Maximum Allowable Pressure* (MAP). In this scheme, the environmental target (blue arrow) leads to MAP and the GES is presented as a 'fuzzy area' on the pressure scale. This is considered to reflect the reality where it is extremely difficult to define the exact dependency between a pressure and state. MAP is defined as an amount of pressure during a specific time period (e.g. a season, a year or an assessment period). The same concept is used in the nutrient reduction scheme of the Baltic Sea Action Plan where Maximum Allowable Inputs of nutrients were calculated for the Baltic Sea sub-basins[2]. For benthic habitats, it was also found relevant to broaden the MAP concept to include also maximum allowable extent of a pressure causing adverse effects. This aspect of MPA was agreed on during the project and in the second HELCOM BalticBOOST workshop on the development of joint principles to define environmental targets for pressures affecting the seabed habitats (28-29 November 2016).

The revised COM DEC on the GES criteria gives a strong focus on spatial assessments. For the criteria related to sea-floor integrity (Descriptor 6), the first and second criteria (D6C1 and D6C2) assess the spatial extent and distribution of 'physical loss' and 'physical disturbance to seabed' (see more on these pressures in WP 3.1 Deliverable 1) and the third criterion (D6C3) requests to define also a threshold for the spatial

[1] Review of the GES Decision 2010/477/EU and MSFD Annex III – cross-cutting issues (version 5)', agreed to be used as a reference document MSCG 5 November 2015.

[2] Nutrient Reduction Scheme in the HELCOM web site: http://www.helcom.fi/baltic-sea-action-plan/nutrient-reduction-scheme/.

extent of benthic habitats being adversely affected. In this light, the concept of MAP is not unambiguous and may require also spatial considerations.

So far, no environmental targets have been developed in HELCOM that address pressures from human activities on seabed habitats. Moreover, there are no agreed methods, guidelines or best practices for setting those, but early initiatives may support the work (e.g. Korpinen et al. 2013, Tillin et al. 2013). Development of environmental targets related to the seabed habitats is a complex task, involving the consideration of many different habitat types, their natural variation, as well as different types of pressures and activities.

The work package 3.1 of the BalticBOOST project has had the objective of developing joint principles to define environmental targets for pressures affecting seabed habitats. During the project, it was decided to call these joint principles 'guidelines', as this term better indicates what the project is developing (GEAR 14-2016, para 3.3). Development of guidelines for setting environmental targets requires information on the relationships of pressure impacts and the environmental state. The information used in this project was based on a literature study of reported impacts of human activities on benthic species and habitats as well as a series of case studies where more data-driven approaches were used to analyse the relationship between impacts and the state of environment. SYKE and IOW focused on non-fishery pressures, SLU and DTU Aqua focused on fishery pressures and ICES encompassed all pressures. Results of these studies are presented in the deliverable 1 of the BalticBOOST WP 3.1.

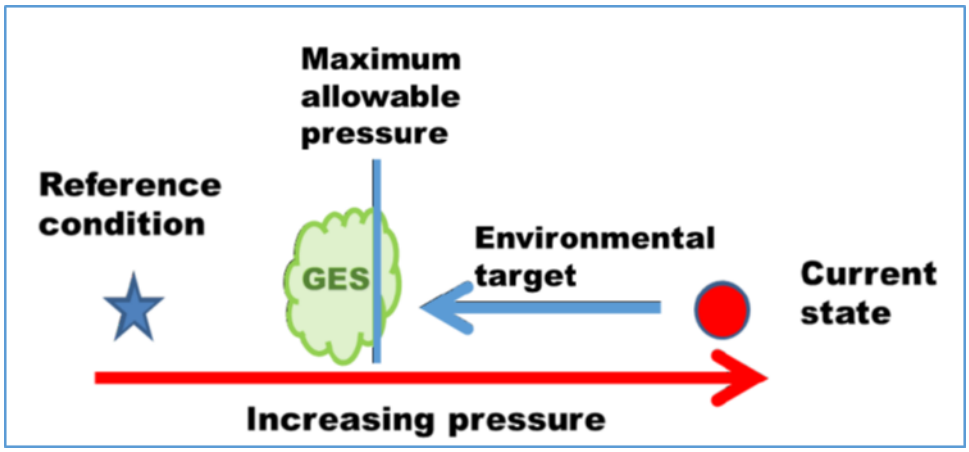


Figure 1. Schematic figure of the relations of GES (green fuzzy area), maximum allowable pressure which is at GES (vertical line) and the environmental target (blue arrow of reduced pressure) on the horizontal pressure gradient (red arrow). The decreasing state gradient is not shown but is in the same direction as the red arrow.

2. Starting points for the guidelines

The setting of environmental targets is probably more difficult for benthic habitats than other habitats, since the benthic pressures are caused by a mixture of several activities which are often measured by different parameters and units. The Deliverable 1 of the BalticBOOST WP 3.1 aimed to find a solution to this complexity. Due to this complexity the setting of environmental targets is not straightforward. In many cases, it is not sufficient to consider single sectors or human activities but the target should be set for a pressure or even impacts (as also guided by the MSFD Annex IV).

The WP 3.1 approach to compare pressures and impacts from human activities with the status of ecosystem components allows a concrete basis for setting environmental targets. Our starting points for an environmental target (ET) are based on case study results and a synthesis of >120 studies and are the following:

- ET is defined for a measurable pressure, often identifiable as linked to a specific activity or sector. This means that ETs are sufficiently specific to enable measurement of their progress and support also necessary management actions.
- ETs should be set separately on the basis of impacts caused by (1) physical loss due to permanent change of seabed substrate or morphology and to extraction of seabed substrate (permanent defined as 12 years) and (2) physical disturbance to the seabed.
- As environmental targets aim to guide progress towards achieving GES in an area by reducing pressures, they should not be conceptually too limited. It is beneficial for their purpose that they can encompass a pressure type in general, a pressure affecting a certain habitat type or even a pressure type in a certain time period, depending on the need. Hence, the environmental targets could be tailor-made to reach GES in specific areas.

2.1 When to consider setting of environmental targets?

According to the document on cross-cutting MSFD issues[3], environmental targets are only necessary to define if GES has not been reached (or there is a risk for sub-GES) and reduction of a pressure can improve the GES status. In our interpretation ETs are not necessary if a pressure does not inhibit any marine element being in GES. There are, however, cases when a specific pressure is not the main reason for a poor status of environment but no other pressure can be managed to improve the status. A non-benthic example is the state of the wintering long-tailed duck which breed outside the Baltic Sea and are declining probably due to pressures in the breeding area. In such a case, management of the minor pressures in the Baltic may be necessary in order to reach GES for the population.

In addition, the following guidance is given on when to developed environmental targets:

- ET may be necessary for a habitat type if an activity is causing high amounts of non-reversible physical loss (e.g. removal of a specific substrate, land filling of marine area, covering a habitat with disposed sediment, etc.). Some substrate types may be preferred by the aggregate industry but a loss of such a substrate is an irreversible loss and hence requires specific regulation.
- ET is necessary if a significant proportion of benthic habitat is affected or lost due to the pressure (preferably at more detailed levels of biotope classification).
- ET's necessity should be considered if the spatial extent of pressure impact is wide.
- ET's necessity should be considered if the pressure lasts for a long time or is continuous.
- ET's necessity should be considered if sensitive or threatened features are at risk.
- ET's necessity should be considered if recovery from the pressure takes a long time.

While the WP 3.1 focused mostly on two pressures – physical loss and physical disturbance – and the activities causing them (**Table 1**), there are also other pressures which affect the benthic habitats and which should be considered when identifying environmental targets (**Table 2**). The guidelines presented in the next section are applicable also to these pressures.

[3] Review of the GES Decision 2010/477/EU and MSFD Annex III – cross-cutting issues (version 5)', agreed to be used as a reference document MSCG 5 November 2015.

Table 1a. Human activities causing Change of seabed substrate or morphology (~ physical loss). The pressure definitions and the lists of human activities are from the linkage framework (Deliverable 1). Grey colour indicates that the activity was included in the catalogue (Deliverable 1).
Finfish mariculture
Shellfish mariculture
Wind energy production: wind farms under construction
Wave energy production
Cables, incl. placement
Extraction of metal ores
Extraction of sand and gravel
Pipelines, incl. placement
Permanent land claim (urban, industrial, leisure, agriculture purposes)
Large-scale water deviation
Canalisation
Culverting/trenching
Coastal dams, weirs
Sea walls
Breakwaters
Groynes
Flood protection
Tidal barrages
Artificial reefs and islands
Dredging (Capital/maintenance)
Beach replenishment/ nourishment
Tourism and leisure infrastructure: Piers
Tourism and leisure infrastructure: Marinas and leisure harbours
Tourism and leisure infrastructure: Slipways
Transport infrastructure: Fishing harbours
Transport infrastructure: Industrial and ferry ports (harbours, bunkering points at sea; oil terminals)
Transport infrastructure: Bridges and causeways
Transport infrastructure: Tunnels
Solid waste disposal, incl. deposit of dredged material
Carbon capture and storage (Carbon sequestration)
Military infrastructure (e.g. military firing ranges)
Waste disposal (munitions)

Table 1b. Human activities causing Physical disturbance or damage to the seabed. The pressure definitions and the lists of human activities are from the linkage framework (Deliverable 1). Grey colour indicates that the activity was included in the catalogue (Deliverable 1).
Finfish mariculture*
Shellfish mariculture*
Wind energy production: wind farms under construction*
Wave energy production*
Cables, incl. placement*
Fishery: Potting/Creeling
Fishery: Netting
Fishery: Demersal long lining
Fishery: Benthic trawling
Fishery: Benthic seining
Fishery: Mussels and scallop dredging
Marine plant harvesting: Machine collection (fucoids, kelp)
Marine plant harvesting: Maerl and Furcellaria harvesting
Marine plant harvesting: Reed harvesting
Extraction of metal ores*
Extraction of sand and gravel*
Oil and gas industry infrastructure (Oil platforms)*
Pipelines, incl. placement*
Coastal dams, weirs*
Sea walls*
Breakwaters*
Groynes*
Flood protection*
Tidal barrages*
Dredging (Capital/maintenance)*
Beach replenishment/ nourishment
Tourism and leisure infrastructure: Marinas and leisure harbours*
Tourism and leisure activities: Recreational boating, yachting
Tourism and leisure activities: Beach use (bathing sites, beaches)
Tourism and leisure activities: Wildlife watching
Tourism and leisure activities: Underwater cultural heritage
Transport infrastructure**:** Industrial and ferry ports (harbours, bunkering points at sea; oil terminals)*
Transport infrastructure: Ship/boat-building facilities*
Transport: Passage of ships/boats
Transport: Mooring, anchoring, beaching, launching
Solid waste disposal, incl. deposit of dredged material*
Military infrastructure (e.g. military firing ranges)
Waste disposal (munitions)
Research and survey: Fish surveys
Research and survey: Environmental monitoring stations

* Activities marked by an asterisk indicate secondary pressures outside the activity's core zone.

Table 2. Other pressures affecting benthic habitats and human activities causing these pressures. Selected activities affecting only benthic habitats have been included from the linkage framework.

Pressure	Activity
Changes to hydrological conditions	Wind energy production: operational wind farms Wave energy production Oil and gas industry infrastructure (Oil platforms) Breakwaters Groynes Artificial reefs and islands Piers Marinas and leisure harbours Coastal dams, weirs
Input of nutrients	Finfish mariculture Shellfish mariculture Urban waste water treatment Industrial waste water treatment Industrial animal farming
Input of litter, incl. micro litter	Netting Benthic trawling Benthic seining
Input of heat	Fossil fuel energy production Nuclear energy production
Deposit of contaminated dredged material at sea	Dredging (capital/ maintenance) Solid waste disposal, incl. deposit of dredged material
Impulsive noise	Wind farms under construction Military infrastructure (e.g. military firing ranges)
Input of organic matter	Finfish mari-culture Shellfish mari-culture
Input of seismic waves	Seismic surveys

2.2 What is the suitable scale for environmental targets?

The geographical scale of the environmental targets is not defined in the EU MSFD (except that they are set for marine regions by Member States), but the project has made the following observations of the relevant scales:

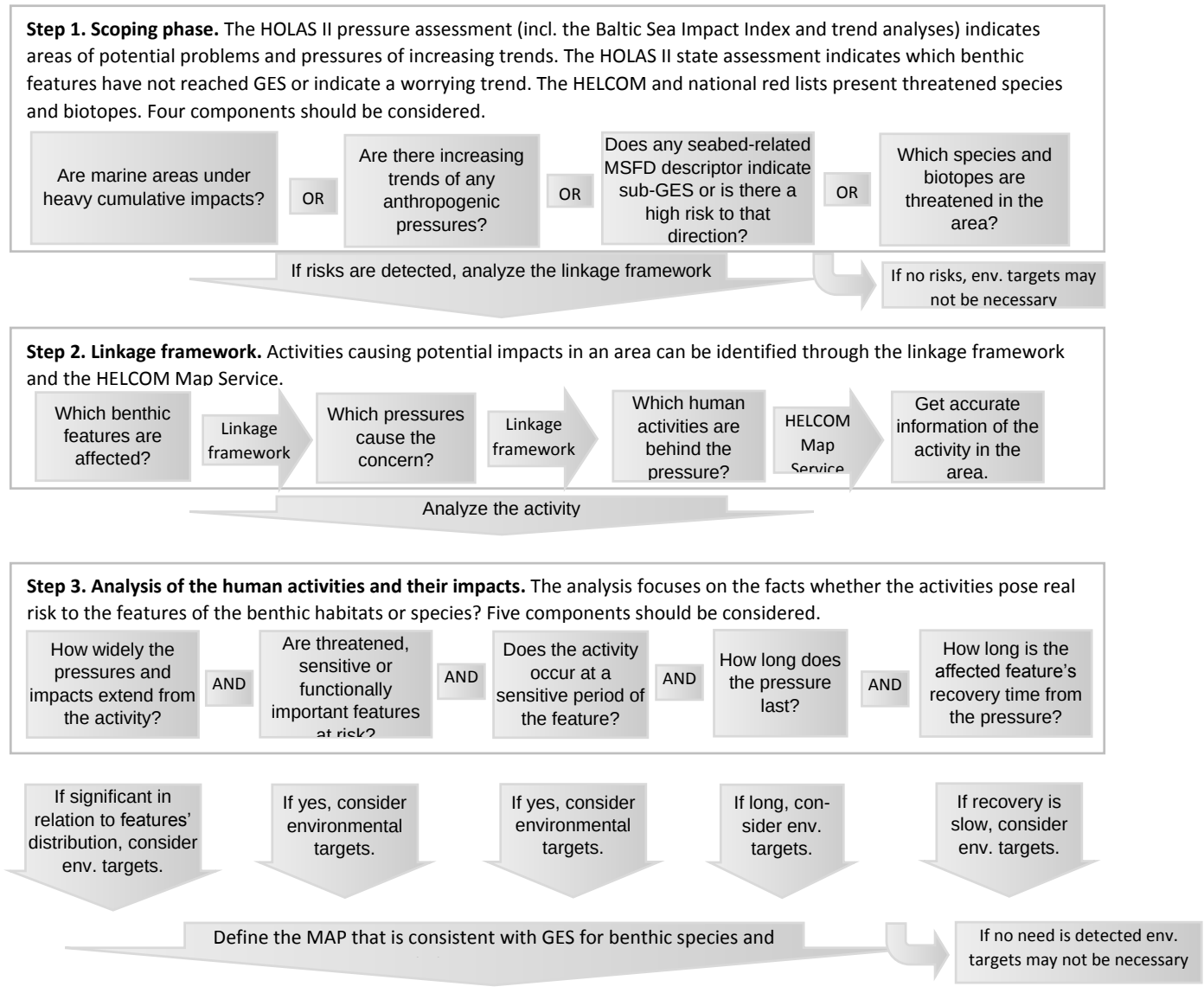
- ET's are defined on a certain scale: either for a marine area, habitat area or an area where adverse impacts are found.
- ET's are assessed on a certain scale: this scale may be different than the scale for definition or the scale may not be even needed (e.g. if the assessment is not spatial).
- It may be advantageous to link the environmental target of pressures affecting seabed with the revised COM DEC which has identified 'subdivision of region or subregion, reflecting biogeographic differences in species composition of the broad habitat type' as the relevant scale for the assessment of descriptor six criteria.
- There may be benefits to link the environmental target of pressures affecting seabed with the benthic core indicators which are assessed on the scale of sub-basins.

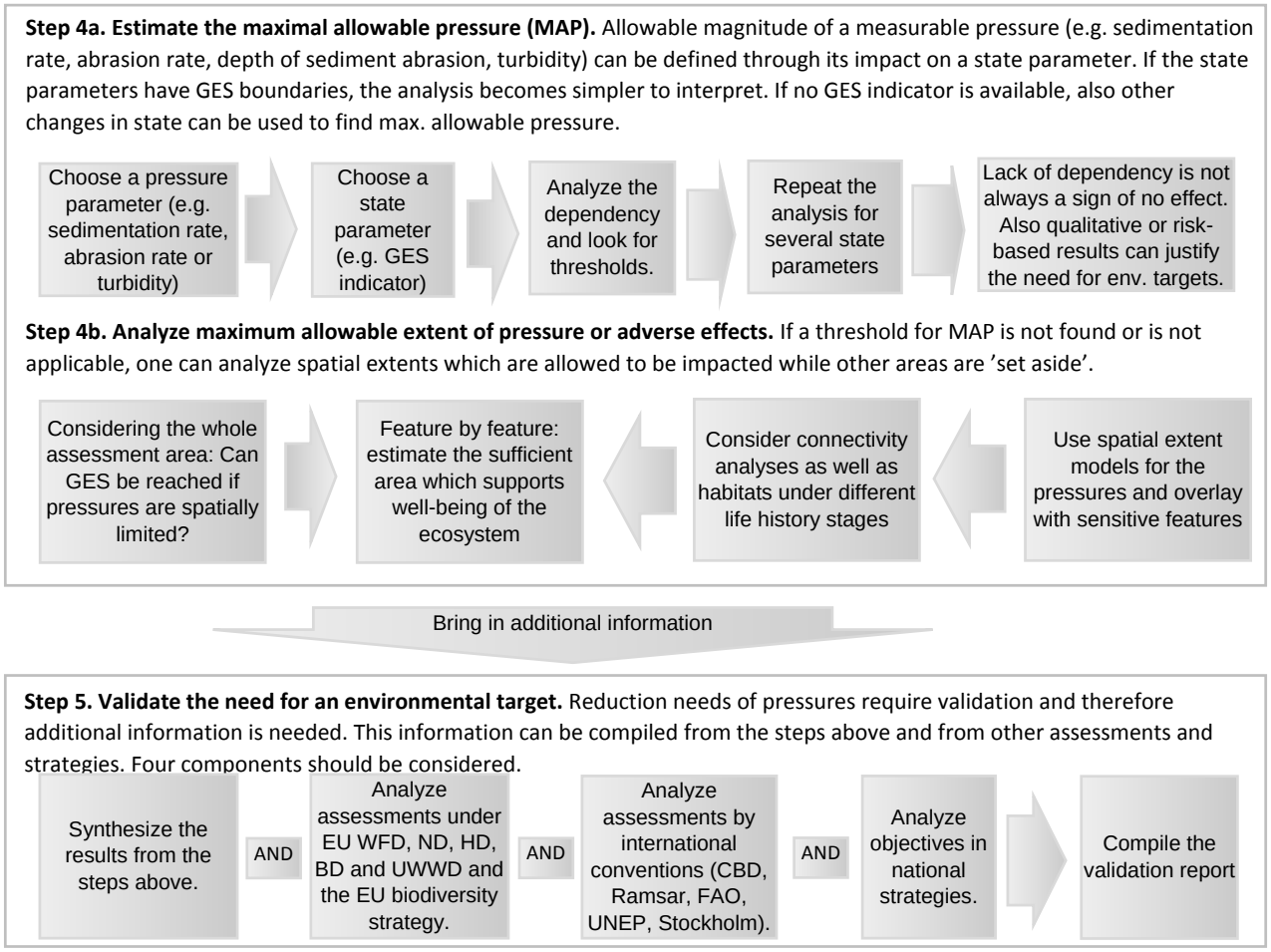
- On the other hand, some benthic biotopes at more detailed HUB level may be restricted to coastal areas and their response to a pressure may be uniform over a wider geographical area. In such a case the ET may be more relevant to define for a larger geographical area, even the entire Baltic Sea or national parts of it. That might be particularly adequate for those biotopes which have been listed as threatened in the HELCOM Red List of biotopes (http://www.helcom.fi/baltic-sea-trends/biodiversity/red-list-of-biotopes-habitats-and-biotope-complexes).

3. Guidelines to set environmental targets

The guidelines are presented in the form of steps which give a general framework for setting of environmental targets for benthic habitats. They take into account the starting points listed in the previous section but do not, as such, include proposals for any pressure thresholds or any activity-specific details.

The guidelines should be read together with the other project results. The case study reports of the WP 3.1 present the findings and limitations of the methods and the Deliverable 1 presents the syntheses that were made on the basis of the case studies and the literature review. Many of the results will directly feed into the HELCOM map products and also the Baltic Sea Impact Index. Therefore, the steps presented in the guidelines can be implemented with the data products which will be available on the HELCOM Data and Map Service and in the HELCOM Second Holistic Assessment.





3.1 Implementation of the guidelines

In this section more concrete proposals for the setting of environmental targets are presented. They are given in the order of the six steps of the guidelines (previous section) and also more practical explanations of the steps are given.

Step 1: Scoping phase. In this step, one becomes familiar with the most recent assessment results and identifies potential problem areas where environmental targets may be required. In addition to the HOLAS II results, also other information sources can be used. The starting points presented in Chapter 2 may support the scoping phase by pointing out the features which should be included in the evaluation. In addition to the MSFD Annex III characteristics also functional habitats, key stone habitats and biodiversity hot spots should be taken into account.

Step 2: Linkage framework. Linkage frameworks are presented in the Deliverable 1 and their results are given in **Tables 1 and 2** of this report. At present the linkage framework indicates only on/off linkages, but they can also indicate the strength of the linkage. This could be based on the ranking of the activities (see Deliverable 1). Confidence of the linkages can be retrieved from the number of information sources where the link has been identified.

Step 3: Analysis of the human activities. Spatial extents of human activities are given in the synthesis document. Similar work is done in the HELCOM TAPAS project (http://helcom.fi/helcom-at-work/projects/tapas) where an expert survey was carried out. This information can be included in any

spatial assessment of physical disturbance and physical loss. GIS data layers including this information will be available on the HELCOM Map Service. Spatial overlay analysis of species and habitats and the pressures could be made available as a HOLAS II product and, at minimum, GIS data layers of benthic habitats and some species as well as threatened biotopes are available on the HELCOM Map Service. Additional spatial data, such as national maps of distribution of threatened biotopes should be analysed as well. Recoverability information of benthic features is given in the synthesis document and will be complemented by the TAPAS expert survey. The step 3 also proposes that duration of the pressure and sensitive seasons should be considered as long-lasting pressure or a pressure taking place in a sensitive time period for a species or habitat will likely affect the benthic features more significantly. Unfortunately the WP 3.1 synthesis did not include sufficient temporal information to allow any conclusion on these matters. However, **Table 3** gives some preliminary considerations on sensitive periods in benthic habitats.

Table 3. Potential overlaps of pressures and sensitive time periods of species. The table is indicative and more thorough analysis of this is needed.

	Physical disturbance		
	Sedimentation	Turbidity	Abrasion, changes in water flow
Infralittoral hard bottom	Late spring -early summer (and autumn in the southern Baltic Sea) is sensitive time for Fucus recruitment, and spring and autumn for herring spawning. Red algae are sensitive year round.	Summer time vegetation growth affected. Red algae are sensitive year round	*No information*
Infralittoral mud bottom	Summer is sensitive for vegetated enclosed bays.	Summer is sensitive for vegetated enclosed bays.	Summer is sensitive for vegetated enclosed bays.
Infralittoral sand bottom	Eelgrass is sensitive year round	Eelgrass is sensitive year round	Eelgrass is sensitive year round
Circalittoral hard bottom	*No information*	*No information*	Mussel beds are sensitive to abrasion year round.
Circalittoral mud bottom	*No information*	*No information*	*No information*
Circalittoral sand bottom	*No information*	*No information*	*No information*

Step 4a: Estimate the maximal allowable pressure. The WP 3.1 case studies aimed to find simple answers to the question 'How much pressure can a benthic feature tolerate and still be in GES?'. In the Deliverable 1 this matter was discussed and only partial answers were provided. The clearest case is the prevention of loss of habitats, where the case studies showed how important it is to consider the biotope definition and have good maps at detailed biotope level. In case of physical disturbance of seabed, the answer is more complicated as in most cases it is not feasible to limit the intensity of the activity because the pressure becomes high already at low activity levels. More useful pressure reductions can be achieved by carrying out the activities at specific seasons, in limited time intervals (e.g. having pauses in the activity), avoiding locations of sensitive species and habitats, concentrating activities to specific areas or selecting techniques

which best fit to the prevailing conditions and locations of sensitive features. For example, a prolonged dredging activity maintains water-column turbidity, which impacts benthic vegetation, and seabed sedimentation, which impacts vegetation, zoobenthos as well as fish spawning. Another example is location of a small-boat harbour, which has been shown to destroy benthic vegetation, fish spawning and zoobenthos in sheltered bays whereas in more exposed shores the impacts remain more limited.

Step 4b: Analyze the maximal allowable extent of pressure or adverse effects. The second WP 3.1 workshop concluded that it may not be sufficient to define the environmental target for pressure magnitudes but also for extents. Hence, 'maximum allowable extent of pressure or adverse effects' may form a more practical environmental target and its implementation may resemble maritime spatial planning or even a network of MPAs. It is also very similar to the threshold given in the revised COM DEC in the criterion D6C3.

The case studies of the WP 3.1 which are presented in Deliverable 1 of the WP described spatial and local approaches for fishery and non-fishery impacts on seabed. The case study results are discussed in Deliverable 1 and they provide valuable information of the methods and approaches to assess pressures and impacts and even management options. For example, it was recommended for fishery impacts to use the FIT-tool which calculates fishing impacts for seabed, for non-fishery impacts to assess the impacts on the finest level of biotope classification and for all pressures to include spatial and temporal extents to the assessments.

Step 5: Validate the need for an environmental target. As environmental targets require political decisions and cause social and economic considerations, sufficient validation is needed to back up the target. This includes a comprehensive synthesis of the analyses (steps 1-5) but also results from other assessments, studies and strategies. For instance, results and recommendations arising from the assessments under the EU Water Framework Directive, Habitats Directive, Birds Directive, Urban Waste Water Directive and Nitrate Directive may provide good argumentation. Moreover, assessment results and recommendations from international conventions such as CBD, Ramsar, Stockholm Convention or UN bodies may give additional information. The EU biodiversity Strategy, Baltic Sea Action Plan and national strategies give important support for setting the environmental targets and may also guide towards the quantitative target (e.g. how many restored salmon or trout rivers are aimed at, etc.).

4. Conclusions

This deliverable has presented the BalticBOOST WP 3.1 proposal for guidelines to set environmental targets for benthic habitats and, hence, they may not be directly applicable to other habitats.

We defined the concept of environmental targets carefully. In Chapter 1 we introduced the term maximum allowable pressure (MAP) in the conceptual figure which is considered to reflect the thinking of the paragraph 2 of the indicative list of characteristics in the MSFD Annex IV. In Chapter 2 we further defined how and when the environmental targets should be set. For example, in order to support the programme of measures, the targets need to be measurable. In Chapter 3 we presented step-wise guidelines what should be considered in the setting of environmental targets and in Chapter 4 we discussed these steps on the basis of our other project findings.

The MAP concept was broadened to maximum allowable extent of a pressure of adverse effects.. When devising measures to reach the environmental targets, spatial restrictions should therefore also be considered e.g. specific techniques for different locations (e.g. a change of dredger or fishing gear, a different cable laying method), protective actions to limit spatial extents near sensitive features (e.g. sediment curtains) and precautionary planning (e.g. avoiding sensitive time periods and areas) can sufficiently reduce the impacts. Spatial concentrations of activities, e.g. through EIAs or marine spatial

planning could reduce impacts by guiding activities away from sensitive areas (e.g. disposal of dredged matter) or concentrating them to some areas (e.g. fishery). The fishery case studies of this project showed that large areas in the Baltic Sea are trawled only little (i.e. trawling concentrates on some areas) and therefore overall fishery pressure would be significantly reduced by preventing fishery from these areas and directing it to the core fishery areas.

In this report, also spatial and temporal scales of environmental targets were considered and recommended as part of the guidelines. Even though the issue of scales is complex, we first noted that environmental targets may require different spatial scales for setting them (i.e. the area where the target applies) and assessing them (i.e. area where they are monitored and assessed). For some environmental targets, spatial scales are not even important. Temporal scales are as complex as the spatial ones, because one scale is needed for the scoping phase (i.e. is the pressure long-lasting or in a sensitive time period and hence requires a target?) and another scale is needed for target setting (i.e. when should the target be met?). There may be additional temporal scales for impacts of specific marine features which have different longevities and therefore different response times to pressures. The project gave only the recommendation of the spatial scale of assessment which would most likely be the sub-basins of the Baltic Sea.

Based on the outcome of the project, we recommend that the aforementioned problems notwithstanding it is possible and necessary to assess, limit and where necessary mitigate the physical effects of human activities on benthic habitats. The results presented here are a first step in achieving this goal.

5. References

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