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Technical Report on the HELCOM Underwater Biotope and habitat classification

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Summary

A typical Baltic Sea community of blue mussels and red algae on a rocky bottom might be classified as a deep water fauna biotope in the northern Baltic Sea and as a small scale mixed community biotope in the south. While biotopes and biodiversity have been studied for a long time in the Baltic Sea, the studies have referred to national standards and definitions of biotopes. The different mapping methods and differences in which parameters are used to define a biotope have created a situation where results are nearly impossible to compare. Due to these inconsistencies, it has been difficult to assess the state of biotopes on the scale of the whole Baltic Sea.

A classification system creates a common understanding of what the underwater biotopes in the Baltic Sea are. This common understanding is especially important when managing underwater environments, since researchers and managers only get snapshots of the environment through different sampling regimes and visual surveys carried out at various locations. Relating the information to a broader underwater landscape context is difficult if no classification scheme exists.

The geological characteristics of the Baltic seafloor that varies from soft mud to bedrock, forms the basis for unique communities of algae, plants and animals. The community composition is further influenced by changing exposure to wave action, differences in salinity, varying temperatures and several other physicochemical parameters. It is often hard to determine where one community ends and another one takes over - the changing community composition is more of a continuum. The basis when developing any classification system is recognising the pattern and the environmental variables that delineate biotopes most accurately.

Developing HELCOM Underwater Biotope and habitat classification

Previously, the HELCOM EC-NATURE Red List Project (HELCOM 1998) was the only Baltic Sea-wide classification scheme for biotopes. The classification was based more on expert judgment and less on biological data. Biotopes were defined mainly based on substrate type and depth zone. More information on underwater biotopes has since become available. In 2007, the HELCOM classification was enlarged to include the Annex 1 habitats of the EU Habitats Directive as well as the habitats of the OSPAR Initial List of Threatened and/or Declining Species and Habitats (HELCOM 2007). Even after these additions the classification was incomplete on the level of biotopes formed by distinct organism communities.

The development of the **HELCOM Underwater Biotope and habitat classification (HELCOM HUB)** has been carried out with the aim to create a common understanding of the Baltic Sea biotopes, habitats and communities. HELCOM HUB is based on the best possible and available biological data and knowledge and was developed by a team of national experts representing all Baltic Sea states. By using tens of thousands of data points from the sea area, biotopes have been defined based on how communities are structured by different environmental gradients. HELCOM HUB defines 328 underwater biotopes and ten biotope complexes.

Biotope classifications that are common throughout the Baltic Sea region will enable smoother communication in future Baltic Sea-wide projects, and will enable a more robust assessment of the level of threat affecting each biotope. In order to develop a classification system which is supportive of the work carried out under the legal framework of the region, the classification has been constructed to be compatible with the European Nature Information System (EUNIS).

Content

1 Introduction

While habitats and biotopes have been studied in the Baltic Sea for decades, it is only in recent years that large-scale mapping and sampling projects have been carried out to produce biological data relevant to biotope mapping. Through these projects, it has become evident that the countries around the Baltic Sea lack a common understanding of what kind of biotopes occur in the Baltic Sea and how they are to be defined.

1.1 What is a classification of underwater biotopes?

The underwater environment is diverse - the distribution of species and the patchwork of biotopes may ostensibly appear to be chaotic. Using a classification system to make sense of this type of information is common in the field of biology. A classification system is a tool that simplifies complex information and relates units to one another. In an underwater biotope classification system, communities of organisms associated with specific environmental parameters are grouped and organised based on how similar or different they are from each other. A classification can be used both to depict similarities and differences between biotopes and to delineate and identify biotopes based on environmental gradients.

Classification systems are often constructed to be hierarchical. In a hierarchical system, units are related to each other as being above, below or at the same level. In a strictly hierarchical system, units can only be connected to other units that are either above or below. For underwater biotopes, it is often highly relevant to arrange the classification so that environmental parameters that affect almost all biotopes are placed high up in the hierarchical structure, whereas biotic factors that only separate a few biotopes from one another are placed lower in the structure. For instance, it is common to split biotopes on a high level based on the availability of light, and at a low level based on the compositions of organisms in the biotope forming community.

The classification of the biotopes must be based on criteria that are coherent and specific enough to classify all the different functional biotopes that occur in a region. Environmental gradients structure biotopes by changing the identity and abundance of predominant species. In the classification system, species abundances that define a biotope within the gradient should be determined so that they can be applied as ecologically relevant cut-off values.

Within the EU, classification approaches have evolved into the European Nature Information System (EUNIS) classification system. EUNIS is a management tool at the pan-European scale. Regions and countries have also developed more detailed EUNIS-compatible tools to suite regional needs. One such example is the 'Marine Habitat Classification for Britain and Ireland' that is developed by the Joint Nature Conservation Committee (JNCC) and classifies benthic marine habitats both on the shores and on the seabed around Britain and Ireland; however, pelagic biotopes are not included (Connor et al. 2004). Biotope classification is needed for management purposes, the implementation of the EU Marine Strategy Framework Directive and for maritime spatial planning, among others.

1.2 The urgent need for a classification of underwater biotopes in the Baltic Sea

Several anthropogenic pressures are currently impacting the Baltic Sea underwater environment in a negative way (HELCOM 2010). The pressures have caused deterioration in the distribution and condition of the underwater biotopes. But no large scale studies of the state of all the biotopes has been carried out due to the lack of a common understanding of how biotopes are defined, hampering the implementation of conservation measures.

This report is a technical report that describes the development of the HELCOM Underwater Biotopes and habitats classification (HELCOM HUB) that was carried out under the HELCOM Red List project. HELCOM HUB will provide a framework for classifying and defining biotopes in the Baltic Sea.

Species and biotopes that have declined and deteriorated to such an extent that they are threatened by collapse can be red listed. The aim of the HELCOM Red List project was to produce a comprehensive Red List of Baltic Sea species and to update the Red Lists of Baltic habitats/biotopes and biotope complexes for the HELCOM area by 2013, as agreed in the Baltic Sea Action Plan in 2007. The five-year project was agreed by HELCOM

HOD 26/2008. The updated Red List of biotopes will provide the groundwork for other actions that will be carried out to meet the target of halting the degradation of threatened and/or declining marine biotopes and habitats in the Baltic Sea, with the objective of having the biotopes in good environmental status by 2021.

Creating a classification system and a Red List of habitats and biotopes for the Baltic Sea is a complex task compared to creating a Red List of species. Historically, species and their distributions have been more intensively studied than that of biotopes. Also, underwater biotopes are not as established as assessable units compared to species. This has previously resulted in highly variable ways of classifying biotopes around the Baltic Sea, further impeding the sharing of data on the occurrence and state of biotopes.

HELCOM published a Red List assessment of biotopes and biotope complexes already in 1998 (HELCOM 1998). However, the classification used in the assessment was simple and ecologically incoherent, considering current knowledge and data availability. This created a need to not only update the Red List of Biotopes and habitats, but also create a new classification system - HELCOM HUB.

In the HELCOM RED LIST Project, a Checklist of Baltic Sea Macro-Species has been compiled listing all known species in the Baltic Sea and the synonym names (HELCOM 2012). The checklist should be consulted if questions on taxonomy arise when using the HELCOM HUB. Species are dependent on the quality and quantity of their habitats. The Red List project assessed the threat status of over 2 700 species or subspecific taxa that occur in the Baltic Sea, of which over 140 were red listed. In order to preserve red listed species, management plans have to ensure the persistence of habitats and biotopes. This connection in nature also links the red list of species to the Red List of biotopes on a management level.

Figure 1.
The checklist supplies information on synonyms and the distribution of over 2 700 species macro-species in the sub-basins of the Baltic Sea.

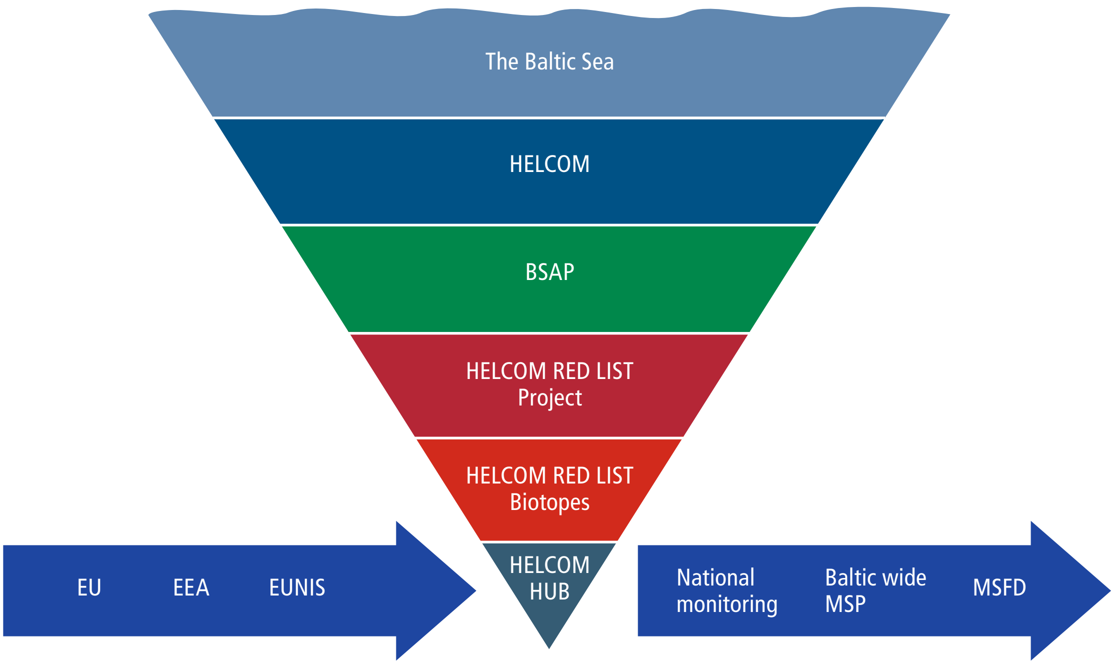


Figure 2. HELCOM HUB can be used as a tool in the implementation of several policies at the national, regional and EU levels.

Box 1. Extracts from the BSAP targets and indicators that are relevant for HELCOM HUB.

In accordance with the Convention on Biological Diversity, HELCOM's overall goal of a favourable conservation status of Baltic Sea biodiversity is described by the following three ecological objectives:
- natural marine and coastal landscapes;
- thriving and balanced communities of plants and animals; and
- viable populations of species.

In order to make the ecological objectives operational and to assess how the objectives have been achieved, initial targets and indicators will be used.

The Contracting Parties acknowledge the need for further research to reach the targets and objectives associated with the favourable conservation status of the Baltic Sea biodiversity, and agree to increase knowledge on and protection of Baltic Sea marine habitats, communities and species:
- by 2011 by updating a complete classification system for Baltic marine habitats/biotopes;
- by 2013 by updating HELCOM Red lists of Baltic habitats/biotopes and biotope complexes, and producing a comprehensive HELCOM Red list of Baltic Sea species;
- by developing further, where appropriate and needed, detailed landscape maps of the Baltic Sea area based on existing information; and
- by 2013 by identifying and mapping the potential and actual habitats formed by species such as bladderwrack (*Fucus* spp.), eelgrass (*Zostera marina*), blue mussel (*Mytilus* spp.), *Furcellaria lumbricalis* and stoneworts (Charales) as well as recruitment habitats for coastal fish using modelling among other tools, and to develop a common approach for the mitigation of negative impacts.

Natural marine and coastal landscapes

Targets:

❖By 2021 to ensure that 'natural' and near-natural marine landscapes are adequately protected and the degraded areas will be restored.

Preliminary indicators:

✓Percentage of marine and coastal landscapes in good ecological and favourable status.

✓Percentage of endangered and threatened habitats/biotopes' surface covered by the BSPAs in comparison to their distribution in the Baltic Sea.

✓Trends in spatial distributions of habitats within the Baltic Sea regions.

Thriving and balanced communities of plants and animals

Targets:

❖By 2021, that the spatial distribution, abundance and quality of the characteristic habitat-forming species, specific for each Baltic Sea sub-region, extends close to its natural range.

❖By 2010 to halt the degradation of threatened and/or declining marine biotopes/habitats in the Baltic Sea; and

❖By 2021 to ensure that threatened and/or declining marine biotopes/habitats in the Baltic Sea have largely recovered.

Preliminary indicators:

✓Percentage of all potentially suitable substrates covered by characteristic and healthy habitat-forming species such as bladderwrack, eelgrass, blue mussel and stoneworts.

✓Trends in the abundance and distribution of rare, threatened and/or declining marine and coastal biotopes/habitats included in the HELCOM lists of threatened and/or declining species and habitats of the Baltic Sea area.

Viable populations of species

Targets:

❖By 2021 all elements of the marine food webs, to the extent that they are known, occur at natural and robust abundance and diversity.

❖By 2015, improved conservation status of species included in the HELCOM lists of threatened and/or declining species and habitats of the Baltic Sea area, with the final target to reach and ensure favourable conservation status of all species.

Preliminary indicators:

✓Trends in the number of threatened and/or declining species.

1.3 Previous classifications developed for Baltic Sea biotopes

Biotope lists and classifications have been developed nationally across the Baltic Sea for different purposes which are reflected in the varying structure and content of the systems. However, all the national biotope lists and classifications have some features in common: biotopes have been delineated based on substrate type and whether the biotope is in the photic or the aphotic zone (Wikström et al. 2010). If ecological features have been specified in the national systems, they usually comprise characteristics or dominant species. Aphotic zones and offshore environments are largely not covered (Wikström et al. 2010).

As the German list of biotopes is based on the Red List of German biotopes, it reflects national conservation aims (Wikström et al. 2010). In Poland, two biotope lists have been created as the result of different research projects. The content of the two lists differs somewhat: one list was developed for GIS mapping algorithms whereas the other was the result of extensive field mapping (Wikström et al. 2010). The Lithuanian national biotope classification was developed to classify seabed zonation while the joint biotope classification of the three Baltic States focused on delineating NATURA 2000 sites (Wikström et al. 2010).

For the Nordic countries, a list of threatened and representative coastal biotopes was compiled in 2001 (Nordic Council of Ministers 2001). This list was based on expert knowledge and has been used in Sweden, for example, but has later been replaced to some extent by the EUNIS classification system. In Finland, Baltic Sea habitat types and complexes were further identified in the first national comprehensive threat assessment of habitats (Raunio et al. 2008).

HELCOM produced a classification of biotopes in 1998 when the Red List of marine and coastal biotopes and biotope complexes of the Baltic Sea, the Belt Sea and the Kattegat was published (HELCOM 1998). This publication includes biotopes of the entire Baltic Sea region, from the underwater biotopes in the pelagic and benthic regions to biotopes appearing on terrestrial coastal areas.

The identified underwater biotopes cover the known substrate types and are further identified based on whether light is present and the presence of macrophyte vegetation. In this system, the vegetation was assigned greater significance in defining biotopes compared to animals. Only few biological data were incorporated in the process of listing the biotopes and they were not defined in detail with regard to specific organism communities. Biotopes were defined by briefly explaining what physical characteristics and which species communities occur in an area; and while it also describes the factors influencing the organisms, the classification does not contain specific split rules for the biotopes. The classification lists a total of approximately 180 terrestrial and underwater habitats, and biotopes (Annex 2).

1.4 EUNIS classification

The EUNIS Habitat classification system was developed to collect harmonised data on habitats throughout Europe. Common criteria for delineating habitats or biotopes cover all natural environments from terrestrial and marine to artificial habitats. The information is used for environmental reporting in several legislative management processes. EUNIS data are collected for the European Environment Agency (EEA) and the European Environmental Information Observation Network and contain information about species, habitat types and sites.

The basis for the marine part of EUNIS is a classification of marine habitats of Britain and Ireland (Connor et al. 2004), developed by the British Joint Nature Conservation Committee (JNCC). The system has been extended to also include marine habitats of other European marine regions, including the Mediterranean and the Baltic Sea. The Baltic Sea habitats that have been included in EUNIS have not covered all known habitats from the sea

The marine and terrestrial environments are divided into ten major classes on the highest level of the EUNIS hierarchy and one group of habitat complexes that also contain some aquatic habitats. Starting with Habitat Type (A) Marine Habitat, marine habitats can be split on six hierarchical levels. The second level is split based on the substrate and availability of light; the third level is based on energy, which mainly describes wave exposure; the fourth level describes communities; the fifth level describes dominating species; and the sixth level groups of dominant species.

An example of the hierarchical structure of the EUNIS habitat types

(A) Marine habitat

- (A1) Littoral rock and other hard substrata
  - (A1.1) High energy littoral rock
    - (A.1.11) Mussel and/or barnacle communities
      - (A1.113) *Semibalanus balanoides* on exposed to moderately exposed or vertical sheltered eulittoral rock
        - (A1.1131) *Semibalanus balanoides, Patella vulgata* and *Littorina spp.* on exposed to moderately exposed or vertical sheltered eulittoral rock

HELCOM HUB has been designed to be EUNIS compatible. The classification system has been compared to the existing marine EUNIS classes in order to establish whether the same habitats or biotopes occur in other marine areas, especially the Kattegat. In the EUNIS system, habitats are coarsely divided according to substrate. Although HELCOM HUB retains the basic EUNIS structure, the substrate type is divided into finer levels (Wikström et al. 2010).

1.5 Environmental gradients in the Baltic Sea

The non-tidal Baltic Sea exhibits several environmental gradients that simultaneously shape and restructure the communities of animals, vascular plants, algae and bacteria. The Baltic Sea is one of the largest brackish-water basins in the world with a very pronounced salinity gradient.

Only a minority of species occurring in the Baltic Sea are specifically adapted to brackish conditions. The majority are freshwater or marine species that tolerate some variation in salinity. As a rule, the salinity increases to the south and in the deep parts of the sea. In the southern areas of the Baltic Sea, the number of species that occur reaches a thousand, whereas only some 300 species occur in the north (HELCOM 2012). While the salinity gradient is distinct and affects the community composition on the scale of the whole Baltic Sea, the salinity gradient is often not so distinct on a regional scale. In oceanic conditions, salinity gradients are often spatially limited to an estuary, for example, and thus the effect on the community structure is more pronounced on a small spatial scale.

In the central parts of the Baltic Sea, a semi-permanent and very pronounced halocline can be detected at a depth of approximately 60–80 meters. The deepest areas in the Baltic Sea are located in the Western Gotland Basin and the biotopes in these areas are strongly affected by the vertical salinity gradient. Large areas are anoxic due to the salinity stratification and the slow water turnover.

On average, the water in the Baltic Sea is more turbid than that of oceans. The attenuation of light is strong in the Baltic Sea, and aphotic habitats are encountered both in the deep central parts as well as in the shallower archipelago areas. The depth limit for photosynthesis varies greatly in different basins in the sea. The absence of light has a strong impact on the community structure that structures the biotope - it is only in the photic zone where light abounds that algae and other types of vegetation dominate the biotopes. The Baltic Sea is, on average, very shallow and is characterised by large archipelagos in several areas. Shallow waters and coastal lagoons form a mosaic of habitats with high biodiversity and several specific biotopes.

The varying coastline, especially in the archipelagos, creates underwater habitats that are affected by wave action to varying degrees (Figure 4). Wave action and energy that is directed at the seafloor has a strong structuring effect on the biotopes. The energy can be determined as a continuum based on various mapping techniques or direct measurements. The Baltic Sea is an inland sea, which means that the strongest energy classes known from oceanic environments do not occur. Very sheltered and shallow lagoons, on the other hand, occur in abundance due to its geology (i.e. land uplifting). The exposure commonly varies over short distances.

Wave action modifies the substrate of the seafloor and affects the composition of the vegetation and faunal communities. The most exposed shorelines in the Baltic Sea in the south are dominated by sandy beaches, in the northern parts the exposed shorelines can also consist of bedrock (Figure 4). As a rule, the substrate type becomes finer the more sheltered the shoreline is. Different organisms have different means of attaching themselves to or burrowing into the substrate. For example, rooted plants are common in sheltered areas where they are attached to the soft sediment by their roots or rhizoids whereas algae require more exposed, hard substrates to attach to.

In the Baltic Sea region, the pronounced seasonal variation affects the distribution and function of most biotopes. In the northern parts, the productive season only lasts for 4–5 months of the year, whereas in the southern parts of the Baltic Sea this period is nearly doubled.

While the seasonal sea ice cover varies year after year, the northern coastal areas of the Baltic Sea freeze regularly. Hard substrates are common on the coasts of the northern Baltic Sea. On these bottoms, perennial algae are scraped off down to depths of a few meters during the winter due to the scouring effect of the movement of the sea ice. These areas that are scraped by the ice are dominated by annual algae during the summer months.

Environmental gradients are used as the basis of most habitat and biotope classification systems. Depth, substrate type and to a smaller degree wave exposure have been regarded as the most important environmental gradients to be considered on small spatial scales in the Baltic Sea (Wikström et al. 2010). On large Baltic-wide scales, salinity is often regarded as having the strongest structuring effect on the communities of plants and animals (Wikström et al. 2010).

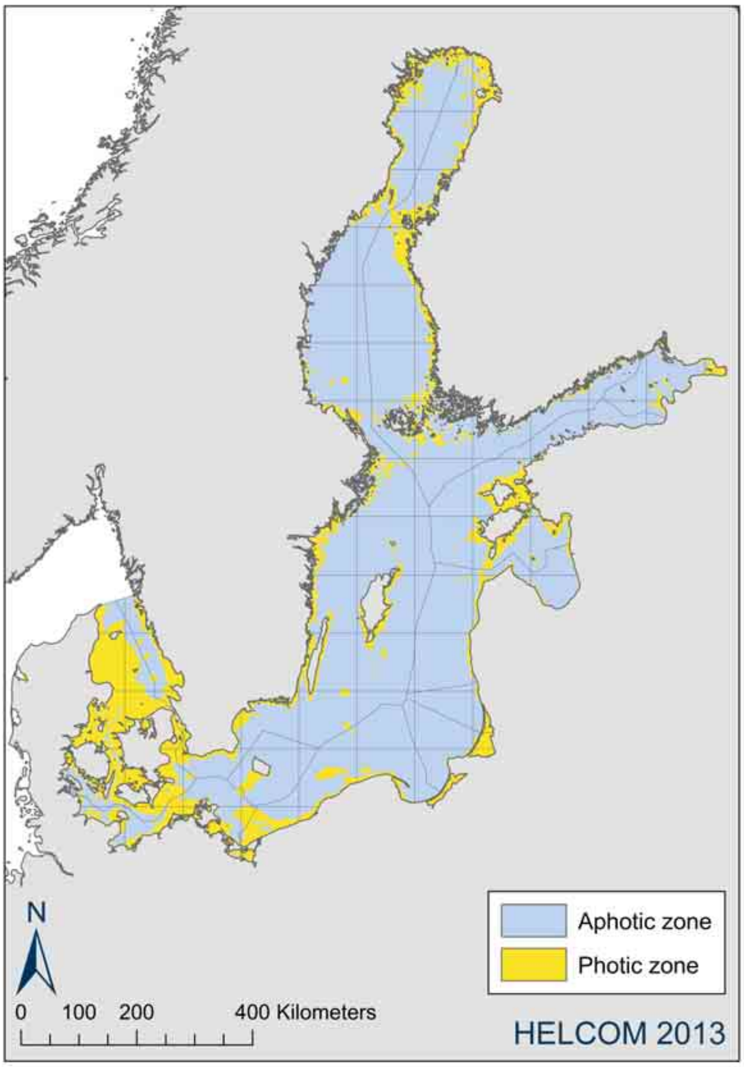


Figure 3. The photic and aphotic zones in the Baltic Sea with a 100 x 100 km European Environment Agency reference grid and coastal countries Exclusive Economic Zone borders (data from EUSeaMap).

Figure 4. Long stretches of sandy beaches make up a straight coastline with high exposure to wave action in the southern Baltic Sea (left). The exposure varies in the mosaic formed by the islands in the Archipelago Sea where bedrock is a common substrate (right). Photo: Lena Avellan, Institute of Oceanology of Russian Academy of Sciences/Elena Kuzmina (Bulycheva)

1.6 Defining a biotope

In HELCOM HUB, a biotope is defined as the combination of a habitat and an associated community of species (Connor et al. 2004, Olenin & Ducrotoy 2006). Habitat is defined by its original definition as the abiotic environment which contributes to the nature of the seabed (Connor et al. 2004). In other words, **habitat** defines the abiotic environment, whereas **biotope** defines the environment together with the associated biotic community. In HELCOM HUB, Levels 1–3 can be seen to describe habitats and Levels 4–6 to describe biotopes.

HELCOM HUB's definition of a habitat and a biotope differs somewhat from that of some other management schemes. In the EUNIS classification, habitat is defined as: "Plant and animal communities that are characterising elements of the biotic environment together with abiotic factors that operate together at a particular scale" (EEA 2013). The EU Habitats Directive and the OSPAR List of Threatened and/or Declining Species and Habitats also include both abiotic and biotic elements in the definition of a habitat.

Figure 5. Sampling must be carried out using appropriate spatial resolution to correctly identify borders between biotopes. Photo: Metsähallitus NHS

While biotopes in HELCOM HUB are generally described on a minimum spatial scale of square meters, the spatial scale at which biotopes should be identified is not strictly defined. In practice, any biotope patch should at least be large enough to function as a biotope, which implies that the organism community is a distinct unit with some distinct function. A biotope has to be biologically and ecologically relevant and the main functions within the biotope should drive the identification. In the EUSeaMap project, a practical application of a 5x5 m scale as a minimum patch size was used (Cameron & Askew 2011).

It is important to consider the spatial scale both when defining a biotope and when designing a sampling scheme. Any single sample of either infauna or epibenthic organisms does not constitute a biotope. If a sample or an area sampled exhibits a mix of substrates or communities, which in HELCOM HUB are defined as separate biotopes, it is important to evaluate the spatial scale that the samples represent. Expert judgement should be used to assess whether the data indicate a biotope defined by a mixed substrate and/or community, or whether the sample might have been taken on the borderline between two distinct biotopes. Patchy distribution of small biotopes within larger, more uniform biotopes might also be difficult to classify based only on single data points if no additional information on the spatial scale of the patchy distribution is available. For instance, blue mussels form small-community patches on sandy bottoms, where a single sample might either indicate a total absence or a complete coverage. When looking at a wider scale, mussel communities may be a significant biotope forming feature of the sandy substrate. In the future when more data are available, it could also be valuable to define the temporal persistence and characteristics of the biotopes that are classified and assessed.

Figure 6. Distinct algal zonation is a typical feature in the biotope complex Boreal Baltic islets and small islands (1620). Photo: Metsähallitus NHS/Julia Nyström

A biotope complex is often a mosaic or some other kind of zonal combination of biotopes, for example, on a landscape scale (Blab et al. 1995). Biotope complexes are assessed on spatial scales of tens of square meters to several square kilometres. In HELCOM HUB, the only included biotope complexes are currently defined through Annex 1 of the EU Habitats Directive. Some other biotope complexes can also form quite regular patterns of patchy biotopes in the Baltic Sea. De Geer-moraines that occur in the Bothnian Bay could, for instance, be considered to be included in HELCOM HUB in potential future revisions. De Geer-moraines are biotope complexes where ridges form a regular pattern every 50–100 meters, which has given rise to the popular name 'washboard moraine' areas. Four different biotopes are typically associated with this structure: one occurs on the seaward side; one on top of the ridge; one on the leeward side; and one in between the ridges. Even though the single biotope patch is small, the complex might cover a large area and, since the patch occurs repeatedly in the seascape, the total area it covers on a large spatial scale can be significant.

1.7 Rare biotopes in HELCOM HUB

The aim when developing HELCOM HUB has been to enable a classification of every corner of the Baltic Sea, even small areas covered by rare biotopes. The inclusion of rare biotopes, even if they are not represented or well documented in the currently available data, is especially important for the Red List assessments of biotopes. The main objective of the Red List project is to list biotopes in danger of 'collapse', which is defined as: 'a transformation of identity, loss of defining features and replacement by a novel ecosystem' (Keith et al. 2013). Biotopes that only occur in a few locations - on rare substrate or otherwise have a restricted distribution in the Baltic Sea - can collapse due to random effects or local pressures.

The data used to create HELCOM HUB mainly originated from national monitoring projects. However, some of the data had a rather coarse resolution and the geographical coverage was not complete as monitoring is often carried out at pre-defined sampling points. For this reason, it is possible that some or even many biotopes, especially rare ones, have remained unidentified in HELCOM HUB. It is therefore necessary to consider the inclusion of additional biotopes into HELCOM HUB in the future when more data on biotopes have become available.

To include as many rare biotopes in HELCOM HUB as possible, additional data sets were added and analysed for specific regions after the initial data compilation and analysis. Data were added at a later stage on the distribution of rare biotopes characterised by sea pens, shell gravel, kelp and peat, among others. These data also described environmental conditions in some specific regions such as the Vistula Lagoon, the Kattegat, a number of lagoons along the German coast and some Russian coastal areas. The split rules had to be specified for rare biotopes, which occasionally required rules that differed from other biotopes at the same level. Biotopes that are known to occur in the Baltic Sea but were not represented in the available data, due to biased sampling designs or a lack of data, for example, were added to HELCOM HUB based on expert judgement.

It should be taken into account that rare biotopes can be artificially generated in a classification system by applying several levels of split rules. Biotopes generated in this way would not be found in nature or in data sets. Biotopes that truly occur in nature and are rare can be verified by resampling areas where they were first encountered. Optimising the number of split rules applied, and verifying the created biotopes is therefore an important process in creating HELCOM HUB.

1.8 How was HELCOM HUB created?

The development of HELCOM HUB was founded on previous classifications of biotopes from the Baltic Sea. The process began by first combining known biotopes from previous classifications made for the Baltic Sea, then identifying additional biotopes from biological data and finally complementing the list of biotopes based on expert judgement.

The development of a EUNIS-compatible biotope classification system for the HELCOM Biotope Red List was initiated within the EUSeaMap project (Wikström et al. 2010). The analyses and the compilation of biotopes for HELCOM HUB was supported by the results and methodology developed in the EUSeaMap project, where the same biotope identification methods were applied. The HELCOM 1998 Red List habitats were included in the initial list created by the project (HELCOM 1998, Wikström et al. 2010). Lithuanian biotopes were also included in the preliminary list of biotopes and classified by substrate, depth zone and biological community (Olenin 1997). Biotopes from the Life Baltic MPA classification as well as the aquatic biotopes in the Nordic coastal biotope list were introduced to the preliminary biotope list and were defined based on the biotope descriptions (Martin et al. 2010, Nordic Council of Ministers 2001). Some aphotic biotopes were introduced to the preliminary list of biotopes from the Lithuanian national zoobenthos monitoring database covering the eastern Gotland Basin down to a depth of 120 meters (Wikström et al. 2010).

The development of HELCOM HUB was mainly carried out by the HELCOM Red List Biotope Expert Group with the support of expert consultants. The work by the experts was carried out during a total of ten workshops during 2010–2013. The team was chaired by Michael Haldin (Finland). The experts contributed by providing data from national databases.

Developing HELCOM HUB could not be carried out exclusively through workshops. The Nordic Council of Ministers granted resources that enabled the collection and analyses of data by expert consultants. Consultants from Alleco Ltd and Aquabiota Water Research compiled and analysed biological

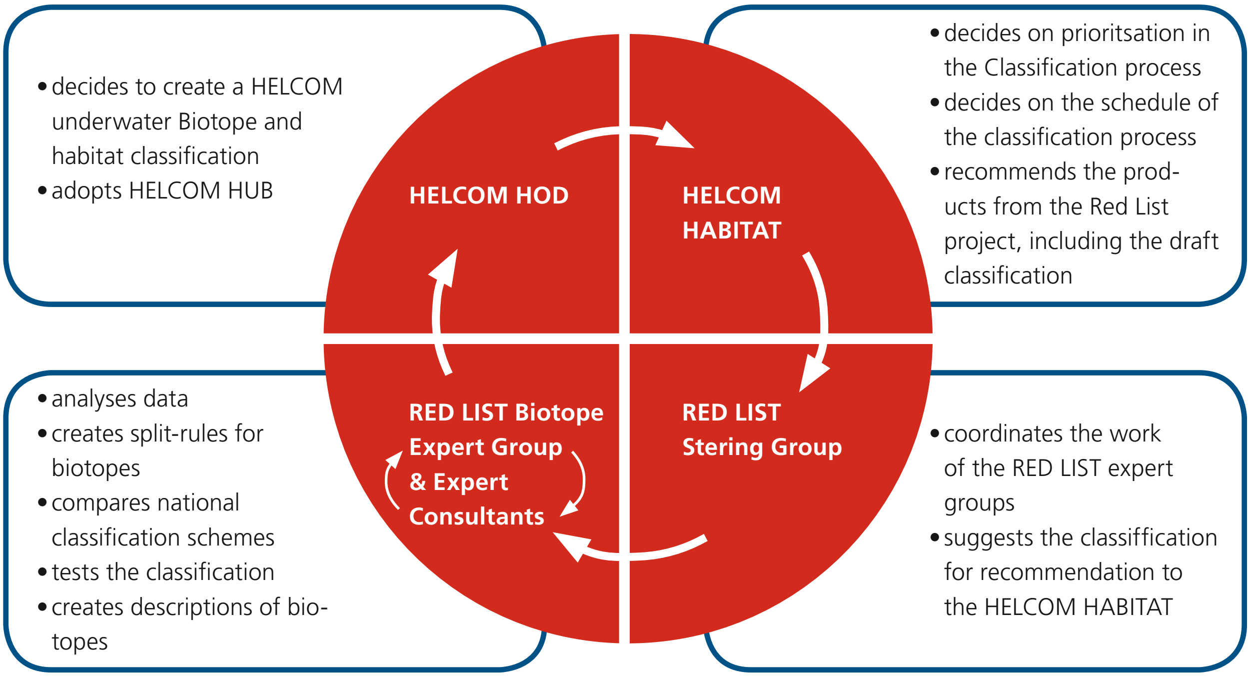


Figure 7. Developing HELCOM HUB was carried out by taking into account the views of experts from several countries and coordinated on several levels by HELCOM.

data, which resulted in a preliminary list of biotopes defined by organism communities. The consultants also collected and compiled other types of information necessary for the development of the classification system, such as information necessary for the description of biotopes. Proposals were presented by the consultants to the Red List expert group who then accepted or revised the classification system based on the information. The work was carried out during workshops and intersessionally.

The initial analyses to find potential biotopes in biological data were made using BalMar, a system developed for the Finnish Inventory Programme for the Underwater Marine Environment, VELMU. The BalMar tool was used in the classification process since it had previously been used successfully to analyse the same type of data that were available to the Red List Biotope Expert Group. These analyses and the compilation of biotopes were supported by the results from the EUSeaMap project, where the same biotope identification methods had been previously applied.

The BalMar system classifies biological data according to the macroscopic species' distinct limit quantity proportions. The classification rules favour perennial vegetation and sessile epifauna over annual vegetation and infauna. Phytobenthic communities from Sweden and Finland, generated by the BalMar tool, were added to the list of preliminary biotopes following the division by substrate, depth zone and wave exposure (Wikström et al. 2010). With these criteria, the dominant species were used to name HELCOM HUB biotopes.

2 Hierarchy and split rules of HELCOM HUB

The aim of the HELCOM Red List Biotope Expert Group was to create a classification system that is as ecologically relevant, logical and practical as possible. The largest part of the HELCOM HUB deals with classifying the benthic habitats and biotopes, pelagic habitats have only been split into a few different habitats (Annex 1).

The structure of the classification system mimics that of taxonomic identification trees, *if criterion X is true, then biotope 1; if criterion X is false, then biotope 2*. Clear split rules leading from one level to another are an integral part in this hierarchical structure (Figure 9). Defining the split rules and what type of information is needed at each level of the classification system has been central to HELCOM HUB's development process.

In order to make HELCOM HUB's system compatible with EUNIS, biotic split rules were only applied after abiotic split rules were applied at the higher levels (Figure 8). Some of the environmental gradients used in the split rules might not be ecologically relevant for all the lower level habitats and biotopes. For instance, macrozoobenthic communities in the photic and the aphotic zone may be the same even though the classification splits the biotope in two. Biotopes that have been split by rules that are not ecologically relevant can be assessed together as one unit, such as in a Red List threat assessment.

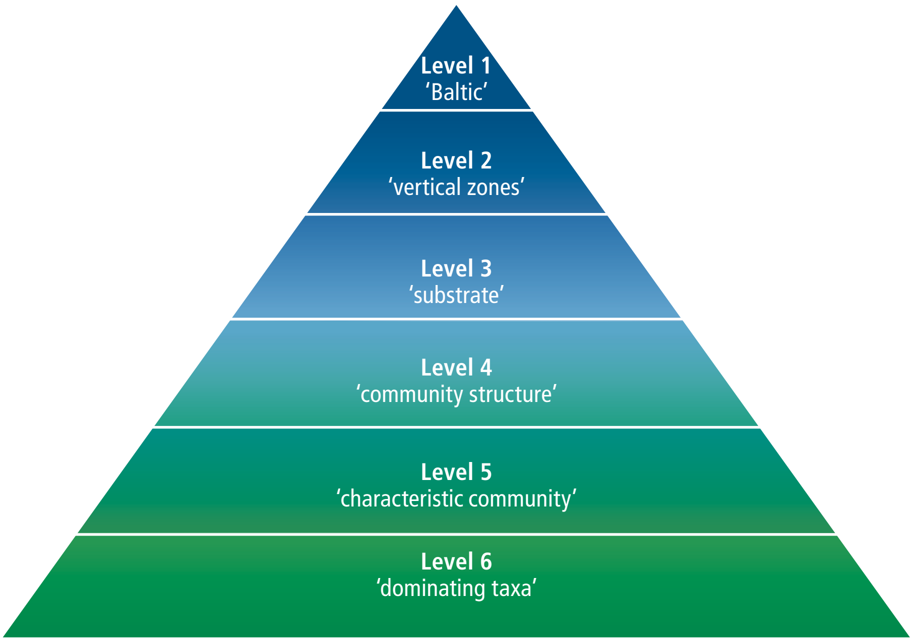


Figure 8. HELCOM HUB is structured into six levels. The higher levels define habitats based on environmental parameters while at the lower levels the biotopes are split based on the composition of the biotic community.

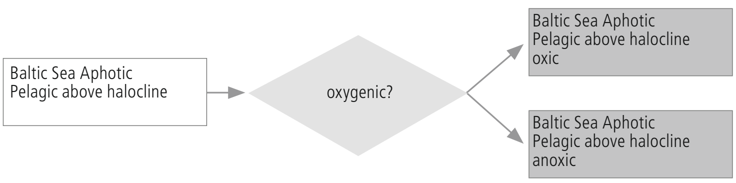


Figure 9. Example of how the hierarchical structure of the HELCOM Classification of habitats and biotopes functions.

2.1 Habitats Level 1 – Baltic

Level 1, all habitats and biotopes are defined based on the region:

- **Baltic**

All biotopes are defined as *Baltic* on Level 1. At this level of HELCOM HUB, biotopes and habitats are thus delineated based on the region where they occur. In EUNIS, the first level splits marine biotopes from several terrestrial biotopes. As HELCOM HUB only applies to underwater biotopes and habitats, the 'marine' split is not relevant. The split on Level 1 is important in order to make HELCOM HUB habitats and biotopes transferrable to the EUNIS system.

2.2 Habitats Level 2 – Benthic, ice or pelagic and the availability of light

On Level 2, habitats are split into:

- **benthic habitats**
- **seasonal sea ice**
- **pelagic habitats**

On Level 2, benthic and pelagic habitats are further split based on the availability of light:

- **photic zone**
- **aphotic zone**

At this level in HELCOM HUB, habitats are split based on whether they are benthic, pelagic or sea ice associated. These habitats and the biotic communities associated with them differ significantly. Benthic habitats are associated with the bottom. Pelagic habitats - habitats associated with the water masses - are delineated in HELCOM HUB and they were also assessed in earlier HELCOM Red Lists (HELCOM 1998). The EUNIS classification splits the pelagic habitat level into several different habitats; however, most are not relevant to the Baltic Sea and thus these splits are not included.

On Level 2, both benthic and the pelagic biotopes are further split into vertical zones by the availability of light. This split is seen to be ecologically highly relevant. Photosynthesising algae and vascular plants occur only in the photic zone and are directly affected by availability of light and the quality of light. The lower limit of the photic zone is delineated by the compensation point, at which depth photosynthesis equals respiration. The depth can be estimated by measuring the availability of light; the compensation point is reached when 1% of the light available at the water surface remains. The compensation point can be estimated by measuring the Secchi depth and multiplying this value by two.

Seasonal sea ice is a very specific and a temporally variable habitat in the Baltic Sea. The sea ice is known to function as the habitat for specialised microorganisms and it is also important for the reproductive success of the Baltic ringed seal (*Pusa hispida botnica*). The seasonal sea ice is not further split in HELCOM HUB, although it can form distinct structures such as pack ice.

2.3 Pelagic habitats Level 3 – Permanent halocline

On Level 3, pelagic habitats are split based on the permanent halocline:

- **above the halocline**
- **below the halocline**

On Level 3 the permanent halocline is the delineating factor of the pelagic habitats. The permanent halocline is a defining feature of the deeper areas of the Baltic Proper, and is usually encountered at a depth of 60–80 meters. The pelagic habitats are split based on whether the water mass is situated above or below the permanent halocline. The pelagic habitat in the photic zone, usually reaches maximum depths of 30–40 meters in the Baltic Sea, and is therefore considered to always be above the halocline.

In the German Belt Sea, a halocline can be encountered within the photic zone; however, the classification system did not regard this feature as a stable habitat defining parameter. Shallow coastal areas, such as boddens, fjords and archipelago areas, were not included as specific pelagic features. Moreover, the thermocline, which is a part of the seasonal cycle in the Baltic Sea, was not included as a habitat defining parameter since the changes in thermoclines are difficult to predict and assess. Although the thermocline is known to be of importance to the summer community of phytoplankton in the pelagic, no particular organisms are likely to be dependent upon it.

2.4 Pelagic habitats Level 4 – Availability of oxygen

On Level 4, pelagic habitats are split based on the availability of oxygen:

- **oxic**
- **anoxic**

The oxygen depletion due to eutrophication and slow water turnover in the Baltic Sea has a pronounced effect on the organism communities. On Level 4, the pelagic habitats are split based on the presence or absence of oxygen: if oxygen is present in the water mass then the habitat is defined as oxic; if no oxygen is present it is defined as anoxic. The anoxic zone is not known to serve as a habitat for any particular macroscopic organism in the Baltic Sea. The extent of the anoxic areas in the Baltic Sea are known to vary over time - both spreading and shrinking in turn. As it is difficult to determine whether the area has been recently anoxic or is permanently anoxic based on single samples, long-term monitoring data are needed to support this split rule.

2.5 Benthic habitats Level 3 – Substrate classes and grain size definitions

On Level 3, the benthic habitats are split based on the dominance of the substrate type:

- **≥90% coverage of a substrate type**
- **mixed sediment**

The composition of benthic communities is known to vary substantially according to the substrate type. Therefore, substrate type is used as a delineating factor on Level 3 for benthic habitats. HELCOM HUB does not define habitat or biotope minimum sizes, neither are stringent rules for defining the borders or a biotope given. When an area is classified through HELCOM HUB, the extent of the area should always be known and the coverage that is asked for in the split rule is the relative coverage of the substrate in the specified area. The coverage is not an absolute surface, but a spatial scale independent coverage percentage of any area that has been measured.

The first step in the split rule for the substrate classes is to test for ≥90% coverage. If no substrate type exhibits ≥90% coverage, the substrate is classified as mixed substrate. *Mixed substrates* comprise any proportion of mix of any substrate type of soft/mobile and/or hard/non-mobile substrates. This is a pragmatic solution which makes the classification complete so that every substrate sample can be classified on Level 3. Experts using the classification should, however, not classify substrates as *mixed substrates* lightly. If the data suggest that the seafloor is covered by 50% *shell gravel* and 50% *coarse sediment*, for example, expert judgement should be used to determine if the area sampled is one habitat defined by mixed substrates or whether the sample has been taken from two different habitats each with ≥90% coverage of the respective substrate type. In the future distinct substrate mosaics creating specific organism communities may be identified, leading to a separation of different types of clearly defined mixed substrate classes on Level 3. Mosaics of substrates are a very common geological feature in the Baltic Sea, especially in the northern regions. The effect on biotopes and mosaics of biotopes caused by mixed substrates is scale dependent. Currently, it is not clear which mosaics at which spatial scale supports communities of organisms with distinctly different dominance proportions and function, compared to there being several small patchy biotopes.

HELCOM HUB recognizes several different substrates that can reach a ≥90%: *rock and boulders*, *hard clay*, *marl rock*, *maërl beds, shell gravel, ferromanganese concretion bottoms* and *peat bottoms*; and three soft substrate classes: *muddy sediment*, *coarse sediment* and *sand*; and finally: *hard anthropogenically created substrates* and *soft anthropogenically created substrates*.

Some of the substrate types included in the HELCOM HUB are quite rare on the scale of the whole Baltic Sea. These substrates were included to ensure that the entire Baltic Sea seafloor can be covered by HELCOM HUB on Level 3. Hard clay is one of the rather rare substrate types - it is of glacial origin and forms patches in the southern parts of the Baltic Sea. Some epifaunal communities are known to exist on hard clay. Marl rock is known to occur in various locations in the Gotland Basin. Coralline red algae form maërlbeds in the Kattegatt, which have a patchy distribution and consist of coralline red alga particles with a maximum diameter of approximately 5 cm. Maërl-beds generally occur at depths of 17–22 meters in areas that are well ventilated and have low levels of turbidity. Concretions of ferromanganese nodules cover patchy areas in the Gulf of Finland and are also known from other areas in the Baltic Sea. Peat bottoms occur patchily along the German Baltic Sea coast and are also known from one location along the Polish coast.

After an initial '≥90% coverage of soft sediment' has been established, one of three soft sediment classes is selected. The soft sediments recognized in HELCOM HUB are *muddy sediment*, *coarse sediment* and *sand*. Any combination of fine materials (silt, clay detritus etc.) should be considered *muddy sediment*. The three soft sediment types are defined though grain size analysis and the grain size definitions are a modification of the EUNIS system (Figure 11) as follows;

1. if the proportion of mud/clay/silt (grain size <63 μm) is more than 20% then the substrate is *muddy sediment*;
2. if the substrate is not *muddy sediment*, then
   a) if the proportion of gravel and pebbles (grain size 2–63 mm) exceeds 30% of the combined gravel and sand fraction, then the substrate is *coarse sediment*; and
   b) if not then the substrate is *sand* (grain size 0.063–2 mm).

A known weakness with the defined substrate classes, which are based on historically defined geological classification schemes, is that no tests have verified whether the defined limits are the most ecologically relevant. It is possible that other limits could be more ecologically relevant (e.g. fauna may be significantly affected already at lower mud proportions than 20%). Currently, there is not enough data from the Baltic Sea region that contains both grain sizes and ecological information. Similar data from other regions are not directly applicable due to the relatively low species diversity and the high proportion of generalists in Baltic Sea communities.

Anthropogenically created substrates are an important part of the classification to ensure that all possible areas in the Baltic Sea are included on Level 3. These substrates are completely transformed by human activity, and thus they should not be

Figure 10. Hard clay is a rare and patchy substrate in the Baltic Sea. Photo: Marilim GmbH/Karin Fürhaupter

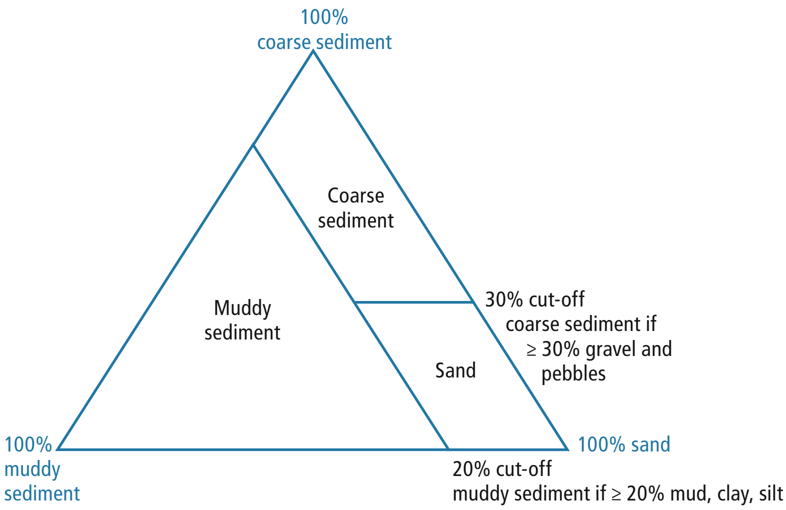


Figure 11. Definitions of mud, sand and coarse sediment in HELCOM HUB are modified from the Folk trigon used in EUNIS.

assessed e.g. in a Red List. When the HELCOM HUB is used for mapping purposes, the anthropogenically created substrates should be delineated strictly according to the actual built or transformed area limits. HELCOM HUB recognises hard and soft anthropogenically created substrates. Hard substrates include for example, underwater sections of pylons supporting bridges, various harbour structures and pipelines. Soft anthropogenically created substrates include for example, dumping sites for dredged materials.

2.6 Benthic biotopes Level 4 – Functional characteristics

On Level 4, benthic biotopes are split based on the structure of the community:

- **≥10% coverage of epifauna or vegetation**
- **0><10% coverage of epifauna or vegetation**
- **macroinfauna present**
- **no vegetation or macrofauna present**

As the structure of the community influences the biotope function, the Level 4 split rule is based on the how the macrofauna community is related to the substrate, and areas where no macrofauna community is present is split into a separate unit. Epibenthic communities dominate on hard substrates such as rock and boulders. Soft substrates, such as sand, on the other hand, may have communities of organisms living both on the surface and burrowed into the substrate.

Epibenthic communities are estimated based on the coverage of the organisms. Since HELCOM HUB does not strictly define the size of a biotope, the coverage is a coverage percentage of any area defined by the expert doing the classification. The biotopes and the name of the biotopes characterised by epibenthic organisms do not separate macrophytes and epifauna on Level 4; instead, the name incorporates both groups in *characterised by macroscopic epibenthic biotic structures*. This grouping of the epibenthic organisms was made based on expert judgement, since it enables an equal treatment of macrophytes and epifauna in the classification on Level 5, which was considered ecologically relevant. Since HELCOM HUB is hierarchical, separating the macrophytes from the epifauna on Level 4 would have made it impossible to directly compare dominance of the groups on Level 5. Such a structure could, for example, have created situations where an area with a macrophyte coverage of 10% and an epifauna coverage of 90%, would have been classified as a biotope characterised by macrophytes, whereas the area is now classified based on the higher epifauna coverage on Level 5.

Figure 12. Burrowing activities of the lugworm (*Arenicola marina*) shapes the biotope (AA.J3M2). Photo: Marilim GmbH/Karin Fürhaupter

Epibenthic communities are split into two groups by the ≥10% coverage cut-off value. The functional traits of a sparse macroscopic community, i.e. with a coverage of epibenthic organisms lower than 10%, is seen to be different from biotopes where the coverage of the same organisms is more than 10%. For instance, the filtering effect of mussels covering only a few present of a substrate will not influence the biotope function in the same way as the filtering effect of mussels covering the whole substrate.

If no epifauna or macrophyte vegetation is present, but macroinfauna can be found in an area, then the split on Level 4 defines biotopes *characterised by macroscopic infaunal biotic structures*. Both the animals as well as the burrows the macroinfauna creates or the shells they live in affect the biotope function. If epibenthic biotic structures occur, even at low densities, then the biotopes are not defined based on the macroinfauna due to the hierarchical structure of HELCOM HUB.

HELCOM HUB biotopes are mainly defined by macroscopic organisms since they have been more intensively studied than meiofauna or microorganisms. The habitats delineated by the absence of macroorganisms can be inhabited by meio- and microorganisms. The split on Level 4 takes both into consideration.

2.7 Benthic biotopes Level 5 – Characteristic community

On Level 5, biotopes are split based on the coverage and dominance of the community:

- **≥10% coverage of a specified taxonomic group**
- **select the dominant taxa/taxons from a group**
- **mixed community**
- **no macroscopic community**

The biotopes on Level 5 are the core for benthic biotopes in HELCOM HUB. Level 5, and to some extent Level 6 biotopes, were created based on biological data, previous classifications and biotope lists created for the Baltic Sea. Biotopes on Level 5 can be used as units in further assessments such as the Red List assessment. Whenever benthic areas or data from benthic samples are classified through HELCOM HUB, the classification should be made down to Level 5. Since every corner of the Baltic Sea is to be classified on Level 5, this level also contains biotopes that are not characterised by any macroscopic organisms.

Communities that constitute biotopes on Level 5 are generally characterised by taxa at the taxonomical level of class or order. The split rules for biotopes characterised by epibenthic organisms on Level 5 are based on a combination of ≥10% coverage and dominance. When a biotope is classified on Level 5, this implies that the substrate is covered to a minimum of 10% by either a group of perennial organisms or some specific group of algae. If the Level 5 biotopes are used for mapping purposes, it is relevant to recognise this inherent ≥10% coverage information. Only if specified species dominates the biovolume of biomass by ≥50% is a biotope further classified down to Level 6.

Perennial organisms are ranked high in the hierarchy on Level 5, since they are seen to strongly influence the function of the biotope. The coverage of annual organisms changes during a season, making it more difficult to use this information for a biotope classification. As HELCOM HUB is hierarchical, this means that on Level 5 the 'attached erect perennial' group has the highest rank, and that a biotope will be defined by the perennial-group whenever the coverage within this group is at least 10%. If no perennial group achieves this coverage, the coverage of unattached perennial vegetation is assessed, and after this the coverage of soft crustose algae and finally the coverage of annual algae (Figure 13).

Figure 13. The coverage of annual algae is estimated if no perennial organisms are present. Photo: Marilim GmbH/Karin Fürhaupter

If no epibenthic group exhibits ≥10% coverage, but based on the split on Level 4 epibenthic organisms cover ≥10% of the substrate, then the biotope is made up of a mix of epibenthic organisms, for example 5% coverage of attached erect perennial algae and 5% unattached perennial algae. Any mix of epibenthic organisms where no single group reaches ≥10% is classified as *characterised by mixed epibenthic macrocommunity*.

The split rules for infaunal biotopes on Level 5 are more straightforward than that of epibenthic biotopes. Infaunal biotopes are defined by a dominance split rule. An area that on Level 4 has been defined as infaunal will be classified purely on the basis of dominance on Level 5. There is no need for a mixed community class that would correspond to *mixed epibenthic macrocommunity,* since it should always be possible to establish dominance based on grab sample data.

Some annual algae grow as epiphytes on perennial vegetation and can, in some cases, exhibit very high coverage. In HELCOM HUB, epiphyte growth is considered more of a quality or status indicator rather than an integral part of the biotope itself; for this reason, no epiphytic organisms are used as a biotope delineating factor in the classification split rules. The design of the classification takes into account that there are areas with 10% cover of emergent plants and 90% cover of perennial algae, and that a dominance split will be the most likely way to classify such a biotope in an ecologically sound way.

2.7.1 Identification of biotopes based on biological data on Level 5

The identification and validation of biotopes on Level 5 was carried out using more than 50 000 data observations and was two-phased. Visual data gathered by drop-video or diving constituting 41 965 observation records from Estonia, Finland, Germany, Latvia, Lithuania, Poland, Russia and Sweden were gathered and analysed together with grab sample data consisting of 7 131 observation records from Estonia, Finland, Latvia, Lithuania, Poland and Sweden. The analysis results were used to create a preliminary list of biotopes. In the second phase, national experts provided some further detailed data sets through which additional biotopes were identified. Grab sample data from Germany and Denmark were made available and compiled (4 875 observations in total). Substrate data were only available for some of the German data and no substrate data were available for the Danish dataset.

The observations made by drop-video or by scientific diving contained information of the percentage coverage of macroscopic vegetation and sessile epizoobenthos species, coordinates, depth and, with a few exceptions, seabed geology (substrate). Based on the coordinates, additional environmental information was added from GIS layers of SWM wave exposure (Isaeus 2004, Cameron & Askew 2011). Information on substrate was missing from 906 visual data observations and was thus not used when creating biotopes in the classification.

All grab sample observations were based on quantitative sampling and the shell-free dry weight was estimated from wet weights according to the literature (Ankar & Elmgren 1978). The taxonomic resolution of the dataset was harmonised to a common level for all the data, since the variation in taxonomic resolution between countries was very large. Substrate information in the datasets was very variable and in the analysis process it was harmonised by converting the observations into fractions of the classes mud/sand/coarse/other.

The biological data was analysed using a BalMar tool (Alleco 2005) according to procedures previously used in the EUSeaMap project (Alleco 2005, Backer et al. 2004, Wikström et al. 2010, Cameron & Askew 2011). BalMar arranges input data into biotope classes at ten hierarchical levels. BalMar levels 1–6 are determined by the physical environment (salinity, light, energy and substrate) and BalMar levels 7–10 by the abundance of species. Whenever two communities dominated a sample, it was classified based on the community with the higher coverage.

In addition to the BalMar tool, other multivariate analyses (e.g. cluster analyses, N-MDS, CCA) were used in order to identify more potential biotopes characterised by fauna. As this was a labour-intensive task, and the fact that much data were received at a late phase of the project, it is recommended that this work is continued in future revisions of the classification system. Due to the large number of zoobenthic samples, it was concluded that it would be necessary to split the dataset before attempting multivariate clustering methods. An initial division of the dataset was made using the Gradient Forests method, which allows identification of biogeographical regions or environmental type classes, based on species turnover along environmental gradients (Smith & Ellis 2012, Ellis et al. 2012). The method uses a permutational approach in order to handle correlated environmental variables.

As environmental data, supplementary data to those associated to the samples (depth, substrate, salinity, SWM wave exposure) as well as data available from the EUSeaMap project (temperature, bottom currents, probability above/below halocline, average number of ice-cover days) was used (Cameron & Askew 2011). Data without substrate information was excluded (mainly offshore Lithuanian samples). In the data analysis, six different zoobenthic biogeographical categories were identified (Figure 14). The data were further split accordingly and used in multivariate clustering and ordination analyses in order to

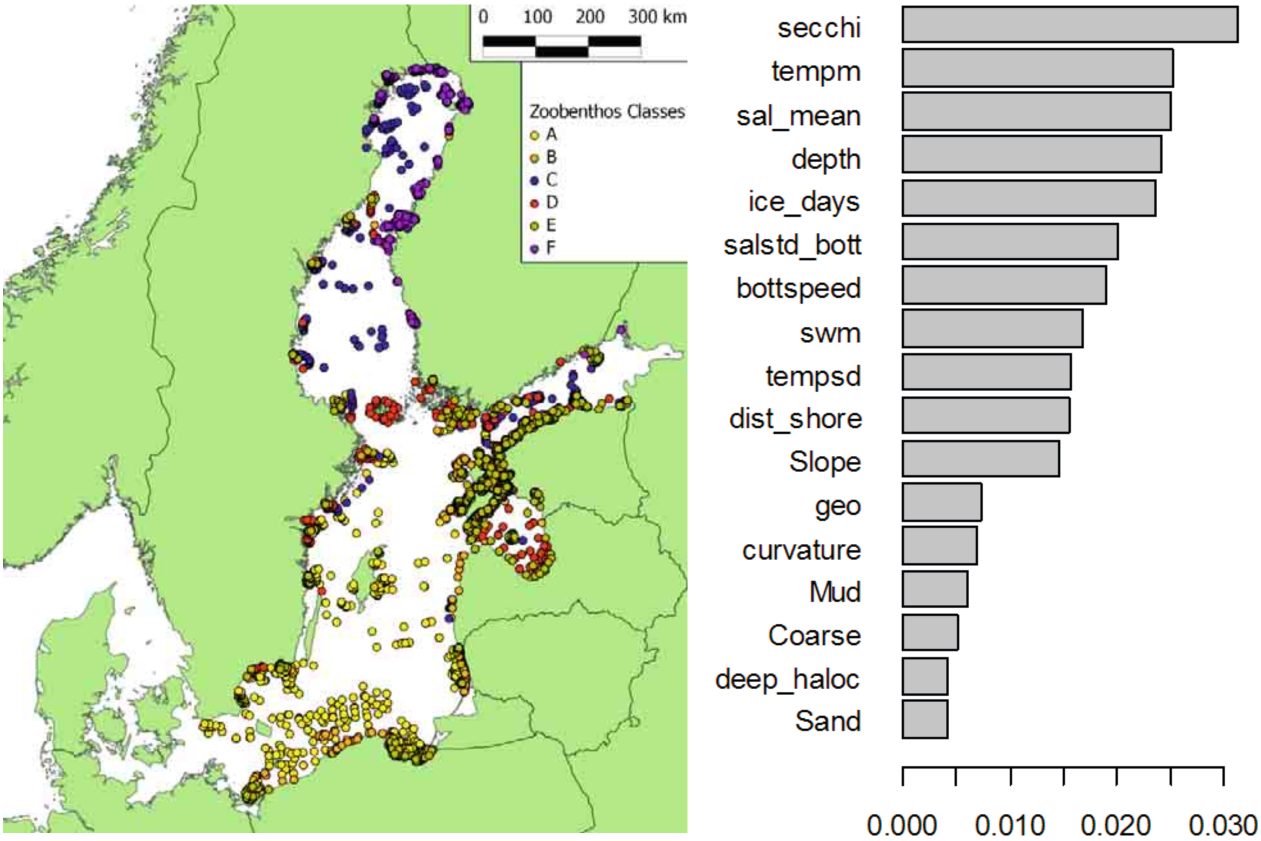


Figure 14. The six biogeographical categories identified in the dataset (left). The R^2-weighted conditional overall importance of the environmental variables for explaining zoobenthic species turnover: Secchi depth; mean bottom temperature; mean bottom salinity; depth; estimated number of days with ice-cover; bottom salinity standard deviation; bottom current speed; wave exposure; bottom temperature standard deviation; distance to shore; slope; geology (large scale); curvature; mud/clay/silt fraction; gravel fraction; probability of being below the deep halocline; and sand fraction (right).

identify additional biotopes for proposed inclusion in the biotope classification system.

The Gradient Forests-method also allowed a detailed analysis of the species turnover along environmental gradients across the whole Baltic Sea. One aim was to evaluate whether the previously proposed abiotic cut-off values between classes were appropriate (Wikström et al. 2010), and if any other appropriate cut-off values could be identified (i.e. are there any specific points along the environmental gradients where distinct thresholds in species turnover occur) (Figure 15).

For wave exposure (SWM), the previously proposed cut-off values (60 000 and 600 000) were not appropriate as they both are located at intervals where the change in species turnover rate is relatively high. More appropriate would be values along the environmental gradient situated directly after a peak, i.e. located in another distinct environmental type category, or at a peak in the middle of an interval between two or more environmental type categories. Possible cut-off values for SWM could be 100 000, 480 000 and 850 000. For depth, no clear cut-off values were identified except at 150 m or 200 m. It should be noted that the number of samples from this depth range was low. Salinity was more difficult to evaluate, but possible cut-off values are 6.5 psu and 5 psu (the previously proposed threshold was 4.5 psu).

Overall, the previously proposed cut-off values to be used in the split rules were not suitable for the zoobenthic communities in the Baltic Sea. This might be explained by the fact that as previous work mainly considered phytobenthic species, it was concluded that it was not possible to find abiotic cut-off values that were suitable for both phytobenthic and zoobenthic species.

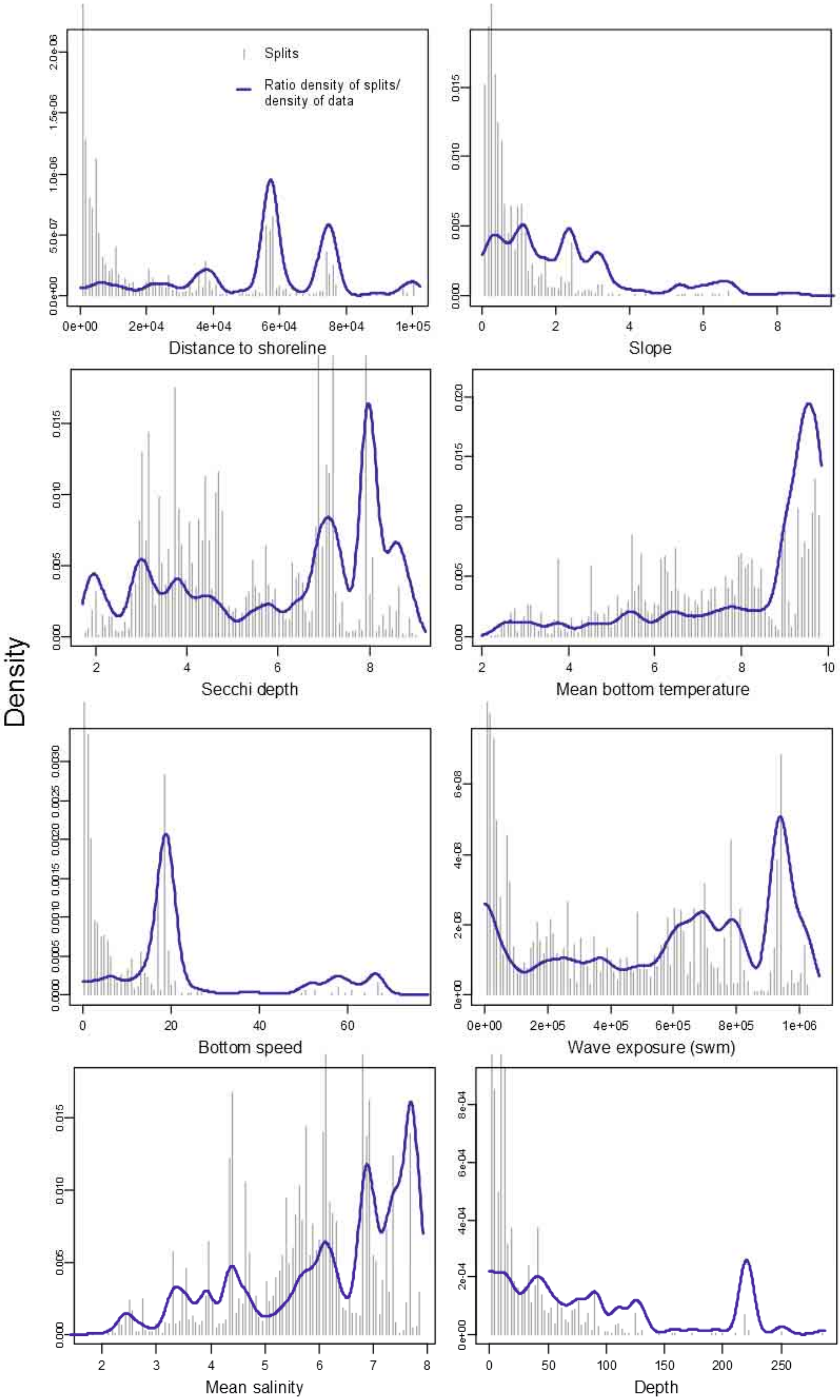


Figure 15. The ratio between density of splits and density of data (blue lines) illustrates the rate of species turnover along the environmental gradients.

2.7.2 Complementing the biotopes on Level 5 by expert judgement

The data-driven biotope identification process did not recognise all the biotopes that are known to occur in the Baltic Sea. To complement HELCOM HUB, biotopes were added to Level 5 according to expert judgement of the Red List Biotope Expert Group. Some biotopes were also added to Level 5 to make sure that it will be possible to classify all future data in some biotope on this level since the classification should always be made down to Level 5.

In the Baltic Sea, several groups of animals attach themselves to hard substrates and remain in the same position. The animals' activities, such as feeding, can impact other organisms living on the substrate and the structures they form can shape the biotope in a distinct way. Depending on the group of animals that dominate a substrate, the function of the biotope will vary. Based on expert judgement, several biotopes dominated by sessile animals with similar life strategies were defined on Level 5, for example biotopes characterised by sponges (Porifera), moss animals (Bryozoa) or polyps (Hydrozoa). In the case that the animals occur together on a substrate, the dominance is to be determined and the area is to be classified on Level 5 based on the most dominant organism (Figure 16).

Shell gravel forms a very specific type of substrate made up of shells mainly from mussels and clams. In the different regions of the Baltic Sea, the shell gravel bottoms appear quite different because in the north the shell gravel is made up almost exclusively of thin-shelled *Mytilus* spp. shells, whereas in the southern parts and in the Kattegat the shell gravel is formed by shells from several species. While some very specific species are known to be associated with the shell gravel habitats, not much information is currently available on the biotope forming communities. Shell gravel biotopes often occur patchily and the patches can be quite small, which explains why this biotope was not encountered in the biological data. Since so little is known about the biotope forming communities, several shell gravel biotopes were formed on Level 5. Two of them, which are only known from the southernmost parts of the Baltic Sea, are split based on the structure of the shells and shell fragments, even though other biotopes are split based on the living

Figure 16. Polyps (Hydrozoa) covering a rocky substrate where blue mussels (*Mytilus* spp.) also occur, the group with the highest coverage defines the biotope. Photo Metsähallitus NHS/Essi Keskinen

organisms on Level 5. Any shell gravel biotopes in the northern Baltic Sea consisting of only Mytilidae shells, should be classified in the Mytilidae dominated biotope on Level 6 (AA.E1E1).

Aquatic moss forms a distinct biotope in areas where it occurs abundantly. Based on expert judgement, the biotope was defined separately from other submerged rooted plants. Aquatic moss often dominates in areas where the salinity is low and commonly forms communities where other plants do not have high abundances. Communities dominated by specific moss species were not defined on Level 6.

In the northern Baltic Sea where rock substrates occur commonly, large areas occur where macroscopic organisms do not occur attached to the substrate. These areas are often covered by microphytobenthic organisms, such as diatoms, and snails that graze on these organisms can also be present in great numbers. Such a biotope was described as *microphytobenthic organisms and grazing snails* and based on expert judgement it was placed under the Level 4 split that delineates areas where epibenthic organisms are present but

Figure 17. Snails grazing on microphytobenthic organisms can cover large areas in the northern Baltic Sea. Photo: Metsähallitus NHS/Mats Westerbom.

rare (Figure 17). The split rule between Levels 4 and 5 is based on the dominance of the microphytobenthic organisms and grazing snails, which can be determined like other dominances either by using biovolume, biomass or coverage. It should be noted, however, that the split on Level 4 delineates areas with less than 10% coverage of macroscopic organisms. If one small fucoid plant is present but the coverage is low, for instance, it may still be dominant over the *microphytobenthic organisms and grazing snails*.

2.7.3 Defining the cut-off values of the split rules for biotopes on Levels 5 and 6

Biotopes in HELCOM HUB are defined based on dominant species. Defining the cut-off value that must be reached by one or several defined species will determine what kinds of communities are seen to be biotope forming in HELCOM HUB. On Level 5, the cut-off value for dominance of coverage must be identified and that for biomass or biovolume for Level 6 biotopes. The name of the biotope is defined based on which species coverage or biomass or biovolume is measured to reach the cut-off value.

An *ad hoc* and pragmatic 50%-dominance cut-off value has been applied in the BalMar tool, which has proven to be helpful when defining biotopes corresponding to HELCOM HUB's Levels 5 and 6. Special software was used to classify the data into the BalMar units that correspond to HELCOM HUB's Levels 5 and 6. Perennial vegetation and sessile animals were given most weight, while annual algae and infauna were used to determine biotopes only when the coverage of the first of these 'community types' has coverage of less than 10%. The abundance of vegetation and sessile animals was determined either by multiplying the percentage coverage with average height of each species (biovolume) or in zoobenthos samples the biomass. For this treatment, each macrophyte species was provided with a value of average height, based on the literature in most cases where it was not included in the original data. For the zoobenthic data, the infauna and epibenthic fauna classes were used with equal weight. Each species was also assigned to a 'community' by adding a corresponding letter to the header line, i.e. P for perennial algae, V for vascular plants, etc. The BalMar 'community' is formed by grouping the dominating species, for example: 'Annual algae', 'Perennial algae', 'Helophytes', 'Charophytes' and 'Epizoobenthos'.

Table 1. The outcome of the BalMar analysis when different cut-off values for coverage on Levels 5 and 6 are applied; the percentage of samples classified in the three different groups is dependent on which cut-off values are applied to the biological data (* *Default BalMar values).*

Cut-off values applied to biological data		Outcome of samples classified in the groups		
Level 5 coverage	**Level 6 biomass/-volume**	**Perennials**	**Macrozoobenthos**	**Azoic**
***)10%**	**)50%*	*64%*	*12%*	*24%*
25%	50%	42%	23%	34%
10%	75%	63%	12%	25%
1%	50%	84%	0%	16%
10%	25%	63%	12%	25%
25%	75%	42%	24%	34%
1%	25%	84%	0%	16%
25%	25%	42%	24%	34%
1%	75%	84%	0%	16%

Estonian coverage estimation data of 6 604 records was classified using variable cut-off values with the BalMar tool. The default values are 10% coverage for the BalMar unit corresponding to HELCOM HUB Level 5 (Perennial, Annual, Macrozoobenthic, Azoic), and 50% biovolume for the BalMar unit that corresponds to HELCOM HUB Level 6. The effect of the cut-off percentages was studied by varying the values for both levels (Table 1).

In the BalMar system, an increase in the cut-off value will result in more samples being placed in biotopes that are characterised by annual algae and macrozoobenthos. When the cut-off values are raised, several species' coverage values have to be added up in order to place a sample in a biotope. High cut-off values would therefore create a need for more biotopes with several species named as a characteristic for the biotope. Lower cut-off values have the opposite effect - decreasing the value places more samples in the 'Perennials' group.

The outcome from BalMar is quite sensitive to changes in the cut-off values, but the resulting change in outcome is also predictable. Higher cut-off values lead to more variation and the classification of more complex (and 'community-like') biotopes. Although the sessile epifauna is included in the 'Perennials' group, if their coverage is less than 10% then any zoobenthos in the sample will classify it as 'Macrozoobenthos' (Table 1). The same principle applies to annual algae.

The default values that were set based on expert judgement, ≥10% coverage on Level 5 and ≥50% biomass or biovolume on Level 6, appeared to be at an appropriate level and ecologically relevant.

2.8 Benthic biotopes Level 6 – Dominating taxon

On Level 6, the benthic biotopes are split based on biomass or biovolume dominance:

- **≥50% biomass/biovolume of specified taxa**

Communities that constitute biotopes delineated on Level 6 are dominated by one or a few species or genera. Some of the biotopes on Level 6 are very widespread, well-known and characteristic for the Baltic Sea, for example, the biotope named *Baltic photic rock and boulders dominated by Fucus spp.* Some other Level 6 biotopes are rare and not much is known about them. HELCOM HUB's Level 6 biotopes were created when either data or expert knowledge clearly indicated that the taxa were biotope forming. The taxa that are mentioned in the name of the biotope or in the split rule are considered to influence the biotope function most.

Biotopes characterised by vegetation are identified based on dominance of biovolume on Level 6. Biovolume was considered to be the best measure of the ecological importance of the species, which indirectly describes how strongly the species influences the biotope function. Biovolume gives a higher importance to large species than a comparison of only coverage, since the height of the species is taken into consideration. Large species are more likely to create habitats for other species, for instance the large perennial fucoid algae form a three dimensionally complex habitat where small animals can find refuge (Figure 18). By applying biovolume as the split rule, the biotope will be classified based on the larger foliose algae instead of small crustose algae, even though the crustose algae might have a higher coverage.

If not directly measured or estimated in the field, biovolume can be estimated by multiplying the coverage with the average height of the species. Separate average height values have been compiled for different basins in the Baltic Sea. Optimally, biovolume should be directly assessed in the field or at least region-specific estimates for heights of full-grown macrophytes should be used. If no such estimates exist, values from a nearby region can be used. Few experts and organisations have collected data on biovolumes. Whenever data are lacking, the tables with height measurements of various macrophytes around the Baltic Sea should be used (Annex 3*).* These measurements were used by the consultants when creating the Level 6 biotopes.

HELCOM HUB allows for any measure of biomass to be used when classifying infauna dominated biotopes down to Level 6. The availability of different types of data should not restrict the use of the classification system. The ≥50% biomass dominance for infauna can be calculated from dry-, wet- or shell-free dry weight. However, wet weights best relate to the biovolume concept.

Figure 18. *Fucus serratus* dominates the community, classifying the area as AA.A1C1 Baltic photic rock and boulders dominated by *Fucus* spp. Photo: Marilim GmbH/Karin Fürhaupter

2.8.1 Identification of biotopes based on biological data on Level 6

In the compiled biological data, biotopes were identified by applying the ≥50% biovolume or biomass split-rule. The analysis was carried out using the BalMar tool.

The most distinct biotope in the compiled biological data was the biotope dominated by *Fucus vesiculosus, Fucus radicans* or *Fucus serratus* that was identified in over 6 600 records. The communities formed by these species are quite similar in function, and thus only one biotope named 'dominated by *Fucus* spp.' was created. Biotopes dominated by other algae were also clearly identified. In more than 2 000 records, *Furcellaria lumbricalis* dominated the biotope, which was named 'dominated by perennial non-filamentous corticated red algae'. The group Charales were also found to dominate some 270 records and clearly forms biotopes on Level 6.

Some common biotopes dominated by different vascular plants were also identified in the analysis. In over 2 000 records, fennel pondweeds (*Stuckenia* (previously *Potamogeton*) *pectinata*) dominated whereas eelgrass (*Zostera marina*) dominated in nearly 1 000 records and the common reed (*Phragmites australis*) made up more than half of the biovolume in some 160 records.

The results also clearly indicated that biotopes dominated by blue mussels (*Mytilus spp.*) exist in several places in the Baltic Sea. Biotopes where ≥50% of the biomass was made up of blue mussels were identified in over 4 000 records.

Blue mussels were also found to be a commonly dominating species in the data gathered from soft sediment habitats (Table 2). In the compiled biological data of soft sediment samples, several species or groups of species were found to dominate the community biomass (Table 2). Biotopes on Level 6 were named based on the dominance of these and other well known, commonly occurring semi-sessile species.

The German IOW data-base was used when defining the biomass split rule for the biotopes named by the presence of the polychaete *Ophelia* spp. The species is characteristic for certain biotopes, although its biomass is small. The IOW

Figure 19. Fennel pondweeds (*Stuckenia pectinata*) and other vascular plants occurred in over 2 000 records. Photo: Metsähallitus NHS/Heidi Arponen

Table 2. Species and groups of species were identified as dominant (≥ 50% biomass) in records from the compiled biological dataset for different soft sediments.

Dominant taxa	Mud	Coarse substrate	Sand
Astarte spp.	x		
Bathyporeia spp.		x	x
Bylgides sarsi	x		
Cerastoderma spp.			x
Chironomidae	x		x
Hediste diversicolor			x
Macoma balthica	x	x	x
Marenzelleria spp.	x		x
Meiofauna dominated (Oligochaeta, Ostracoda, Nematoda)	x		x
Monoporeia affinis	x		x
Mya arenaria		x	x
Mysidae	x		
Mytilus edulis	x	x	x
Pontoporeia femorata	x		
Saduria entomon	x	x	x
Scoloplos armiger	x		

database contains approximately 1 000 stations between Flensburg and Usedom and data collected between 2003–2012 with a van Veen grab (0.1 m², 1 mm sieve, 3 replicates per station) was analysed. In these data, the *Ophelia* spp. biotope could be identified applying a split rule which first omits the biomass of bivalves and only a >10% biomass of *Ophelia* spp. and/or *Travisia* spp. This split rule is quite different than other split rules for Level 6 biotopes; however, the expert judgement was that the *Ophelia* spp. biotope is valid and ecologically relevant. Thus a split rule that identifies the biotope at locations where it is known to occur was incorporated in the classification. Since the split rule demands the biomass of potentially present bivalves to be disregarded, it was not possible to place this *Ophelia* spp. dominated biotope under the Level 5 biotope *characterised by infaunal polychaetes* as the area would be classified on Level 5 under the biotope *characterised by infaunal bivalves*. To overcome this practical problem, the biotope *dominated by Ophelia spp.* was placed under the Level 5 biotope *characterised by infaunal bivalves* although the species that are characteristic for the biotopes are polychaetes.

2.8.2 Complementing the biotopes on Level 6 by expert judgement

During the development of the HELCOM HUB classification system, it was apparent, that the biological data together with earlier biotope lists and classification systems did not cover all the biotopes that are known to occur and that are dominated by one or a few species. In order to complement the classification system on Level 6, expert judgement was used in several cases.

2.8.2.1 Level 6 biotopes dominated by macrophytes

In the photic zone along the whole Baltic Sea coast, the predominant algae belong to the alga family Fucacae, which was also seen in the compiled biological data. A few species in the genus *Fucus* spp. occur in the Baltic Sea and were all classified in the same biotope on Level 6 *dominated by Fucus spp.* The species *Ascophyllum nodosum* belongs to the same family and occurs in the Kattegat region. Due to the species restricted distribution and uncertainty of whether it is biotope forming in the Kattegat, it was not included in the biotope name on Level 6. Therefore, the biotope was not named 'dominated by Fucace' which would have included *A. nodosum.*

The special unattached dwarf form of *Fucus vesiculosus* (sometimes referred to as *Fucus vesiculosus* forma *pygmaea*) is known from German and Swedish waters and has also been known to exist in Poland. Since the dynamics of an unattached aggregation of *F. vesiculosus* of the normal and the dwarf form are distinctly different, they are viewed as separate biotopes. Moreover, the dwarf form is in itself completely different from the normal form and the habitat is different for animals that inhabit it. The special rolling forms of *F. vesiculosus* that are roughly the size of a football and occur on large soft bottom areas are not viewed as a distinct biotope, but can be seen as biotope elements of the specific soft substrate biotope and not as separate biotopes.

Figure 20. *Zostera noltii* occurrs in the Kattegat and Belt Sea (AA.L1B2 Baltic photic sand dominated by *Zannichellia* spp. and/or *Ruppia* spp. and/or *Zostera noltii*). Photo: Marilim GmbH/Karin Fürhaupter

The biotope *dominated by perennial foliose red algae*, such as *Phylophora* spp., was included based on expert judgement. The biotope was not apparent in the data and occasionally *Phylophora* spp can be difficult to identify in drop-video data. Biotopes *dominated by kelp* were also introduced based on expert judgement. These biotopes dominated by perennial algae were only introduced on photic hard substrates in HELCOM HUB.

Zostera noltii is a rare species in the Baltic Sea area and occurs mainly in the Kattegatt region. The species did not appear grouped in any vegetation community in the available biological data. It was included in the split rule and name of a biotope on Level 6 associated with *Zannichellia* spp. and/or *Ruppia* spp., since it is known to form mixed communities together with plants of these genera in German waters.

2.8.2.2 Level 6 biotopes dominated by fauna

Nectobenthic mysids (Mysidae) can occasionally occur in very large densities on large areas of unvegetated sandy bottoms in the Bothnian Bay and can even dominate the biomass of an infauna community (Table 2). These mobile crustaceans live near or on the bottom and are known to be efficient bioturbators. Occasionally, they can be caught in the grab samples. However, the classification system was built on sessile or low mobility zoobenthic communities and therefore the nectobenthic animals are not seen to be biotope forming. Following the current classification system, the areas where nectobenthic animals are abundant will be classified as another biotope (e.g. characterised by meiofauna or infaunal Crustacea). If more knowledge and data on nectobentic fauna becomes available, it is recommended that the classification system reconsiders the addition of relevant nectobenthic/benthic-pelagic interphase biotopes. Based on the same principle, biotopes are not defined based on the presence of the highly mobile isopod *Saduria entomon* even though it has been found to dominate samples due to its large size (Table 2).

The biotope characterised by sea pens was clearly identified as a valid and ecologically relevant biotope by expert judgement. It was agreed by practical reasons that this should overlap as far as possible with the OSPAR class 'Sea-pens and burrowing megafauna communities'. As this biotope has also been identified to be in need conservation measures, it was important that when classifying data that contain sea pens the classification will lead as directly as possible to the sea pen biotope. The sea pen biotope is placed under the class defined by 0><10% coverage of macroscopic epibenthic biotic structures on Level 4. Sea pens are conspicuous where they occur, but do not reach high coverages. Using the biomass of sea pens was also not deemed appropriate, as the mass of potentially occurring infaunal organisms could be higher than that of the sea pens. Thus the split rule was set to presence or not of 'conspicuous populations of sea-pens'. It should be noted that sea pen biotopes should be mapped using visual methods such as ROV or diving and the biotope might also require further grab sampling in order to be accurately identified.

Areas are known from the southern Baltic Sea where several bivalve species co-occur. These areas are quite specific and characterizes by the co-occurrence and the high species diversity. This biotope is delineated in HUB by naming the characteristic species *Macoma calcarea* and/or *Mya truncata* and/or *Astarte* spp. and/or *Spisula* spp. HELCOM HUB also recognizes biotopes where some of these species constitute more than 50% of the biomass. To ensure that the biotope of co-occurring species is classified correctly, the split rule states that at least two of the named bivalves have to make up ≥50% of the biomass.

The class Anthozoa was split into separate biotopes on Level 6 based on expert judgement. These are *dominated by sea anemones* (*Actiniarida)*, *dominated by stone corals* (*Scleractinida)* and *dominated by soft coral (Alcyonacea)*. The data did not suggest that these biotopes occur in the photic zone, but they can however be added if future data support the inclusion.

Moss animals (Bryozoa) are separated into two different biotopes based on the growth form of the dominating species - the crustose form and the erect form. Typical species are the crustose *Electra crustulenta* and the erect *Flustra foliaceae*. The erect moss animal biotopes are threatened by siltation in the southern Baltic Sea, whereas the crustose type is very common in the northern Baltic Sea and not threatened. This created a need to separate the biotopes.

Monoporeia affinis and *Pontoporeia femorata* often co-occur on aphotic muddy substrates. As dominance of the respective species is mainly determined by depth and associated salinity, they are seen to form one community with variable composition. There is also a large functional overlap of areas when the species do not co-occur, which led to the combination of the communities where the species dominate into one biotope type. Two sub-types of this biotope could be included in future revisions of the classification system if data support a distinction.

Figure 21. The erect moss animal hornwrack (*Flustra foliacea*) occurs is biotope forming in the southern Baltic Sea (AB.AH2 Baltic aphotic rock and boulder dominated by erect moss animals). Photo: Marilim GmbH/Karin Fürhaupter

2.9 Biotope complexes

Some of the biotopes and habitats listed in HELCOM HUB co-occur and function together in the underwater environment. Biotope complexes consist of a number of different biotopes that occur together and are affected by the same specific environmental gradients. For instance, coastal lagoons can be made up of areas where the sediment is bare and areas with different communities of macrophyte vegetation. In a lagoon, all the biotopes can be affected by warmer water temperature and lower salinity, for example, than outside the lagoon.

HELCOM HUB does not currently encompass all biotope complexes that occur in the Baltic Sea. A number of biotope complex forming natural features such as bubbling reefs, reefs, sand banks, coastal lagoons and other habitats that are listed in the Habitats Directive Annex 1 are present in the Baltic Sea (Table 3). These ten complexes are recognised in HELCOM HUB. The definitions of the habitat complexes follow the description for Habitats Directive Annex I Habitats in the Interpretation Manual of European Union Habitats (EUR 27, July 2007, European Commission).The descriptions of the habitat complexes and periodic reporting on the status are legally binding requirements for EU member states.

Table 3. Habitat complexes that occur in the Baltic Sea and are included in the classification.

Code	Biotope Complexes (Habitats Directive Annex 1 habitats, EUR27)
1110	Sandbanks which are slightly covered by seawater all the time
1130	Estuaries
1140	Mudflats and sand flats not covered by seawater at low tide
1150	Coastal lagoons
1160	Large shallow inlets and bays
1170	Reefs
1180	Submarine structures made by leaking gas
1610	Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation
1620	Boreal Baltic islets and small islands
1650	Boreal Baltic narrow inlets

2.10 Environmental gradients not included in HELCOM HUB

Biotopes are shaped by several environmental gradients. Identifying the significant environmental variables and the cut-off values to be used as split rules at the different levels required detailed analysis of the biotope forming communities and how they are structured by the environment.

Although it is well known that the salinity gradient impacts the distribution of species in the Baltic Sea, it is not included in the HELCOM HUB classification system as a biotope delineating parameter that would be described through a split rule. The exclusion of the salinity gradient is partly a practical solution, as including salinity as a parameter would have increased the number of classes significantly. Moreover, no specific ecologically justifiable cut-off values to be used in the split rule as biotope delineating factors were identified. Separating areas of salinity <4.5 psu (oligohaline) and areas of salinity >18 psu (polyhaline) from the salinities in between (mesohaline) was suggested because some species are sensitive to these salinity thresholds, such as charophytes, kelps, echinoderms and a number of other stenohaline organisms (Wikström et al. 2010). However, these cut-off values were not supported in the biological data (Figure 15).

On a Baltic Sea scale, the salinity split was seen as problematic for several reasons, one being that oligohaline areas occur largely in the Bothnian Bay in the north as well as in bays and lagoons in other parts of the Baltic Sea. Grouping these biotopes based on salinity is not necessarily ecologically relevant (Wikström et al. 2010). Also, some species co-occur as biotope-forming communities in one area, but might occur at a different abundance composition in another. This gradual change would make the classification of a biotope with the same ecological function but slightly different dominance of the species at a different salinity somewhat difficult.

The permanent halocline in the pelagic habitats is the only case where a salinity gradient is used as a split rule in HELCOM HUB. It should be noted, however, that several of the biotope forming species that are regarded on Levels 5 and 6 require a very specific level of salinity. Accordingly, salinity is inherently included in the definitions of biotopes but not used as a split rule.

For benthic habitats, the effects of wave energy can be clearly seen in the shallow areas. Wave energy and different exposure indexes were analysed as potential environmental gradients used in the split rules. No practical cut-off values were identified when studying species turnover (Figure 15); moreover, the exact impact and structuring effect of wave action on biotopes situated deeper down is difficult to determine. The analysis of the biotope structuring effect of the speed of the bottom current did not yield any clear cut-off values (Figure 15).

Similarly to the salinity gradient, wave energy and water movement were included only indirectly in HELCOM HUB through the substrate type. Substrate type is directly affected and structured by wave energy, but it is also affected by other environmental variables. Wave energy is known to structure communities and is often described by cartographic methods. The structuring effect on communities by substrate type is however, thought to be stronger. Accordingly HELCOM HUB uses substrate type as a delineating environmental variable as it is known to have a great impact on the organism community, in addition it crudely and indirectly incorporates wave energy.

3 How to use HELCOM HUB

The HELCOM HUB classification integrates national classification schemes and previously described biotopes as well as environmental and biological data. Moreover, the classes are designed to be EUNIS compatible and transferrable. HELCOM HUB can be used to identify biotopes and classify data in the entire HELCOM area. The classification can be incorporated in GIS analyses and the split rules can also be applied when mapping projects are carried out in the field.

When all habitats and biotopes in the classification that can be used for further assessment are taken into account, HELCOM HUB defines a total of 328 habitats and biotopes and further recognises ten biotope complexes. HELCOM HUB is built on six levels that describe different aspects of the underwater environment. No level of the classification can be passed over to reach the next level due to a lack of data. The classification of habitats and biotopes should always rely on sufficient data. It is recommended that quantitative data from field samples is used, especially when classifying biotopes down to Level 6 where the split rules rely on biomass and biovolume ratios.

When benthic biotopes are classified using HELCOM HUB, the process should always be carried out to Levels 5 or 6. The rare substrate types that are described on Level 3 are an exception to this rule; for example, ferromanganese concretion bottoms are not classified further. For the more common substrate types, the classification has been designed so that no 'dead ends' should be encountered before Level 5.

3.1 Management benefits of an underwater biotope classification

The HELCOM Baltic Sea Action Plan (BSAP) is the strategy for implementing the ecosystem based management approach in the Baltic Sea region. In the approach, natural processes and human activities are managed through an integrated scheme that takes into account the dynamic nature of the environment. HELCOM HUB is a tool that integrates several environmental factors in the biotope units. Biotopes are dynamic entities and, as a rule, they are more persistent than the distribution of single species. Classifying areas through HELCOM HUB and mapping the areas on a management scale will support the implementation of several policies at a regional level. HELCOM HUB will support the use of the same nomenclature and criteria for delineating biotopes in the whole Baltic Sea.

Marine spatial planning (MSP) is an important tool for managing human activities in the Baltic Sea and links several different interests and stakeholders. MSP can only produce robust and useful maps of the marine area if the environmental data included in the maps is of high quality. By applying HELCOM HUB to biotope data in the whole Baltic Sea area, it will be possible to create comparable pan-Baltic maps of the distribution of biotopes. Previously, this kind of information was only available nationally. It is also important that the distribution of threatened biotopes sensitive to specific anthropogenic pressures is taken into consideration when planning Baltic Sea scale shipping routes or networks of Marine Protected Areas (MPA), for example.

HELCOM HUB will support national implementation of the Marine Strategy Framework Directive (MSFD), which aims at maintaining or reaching good environmental status (GES) of European marine regions by 2020. GES is defined by qualitative descriptors, with two descriptors addressing specifically habitats and biotopes: Descriptor 1 for habitat extent, distribution and condition and Descriptor 6 for the extent of biogenic habitats, condition of benthic communities and impacts on benthic habitats. HELCOM HUB biotopes have been defined on a scale that supports mapping the seascape on the level that is needed to fulfil the MSFD needs. Habitat complexes are also included in HELCOM HUB as most of the HELCOM Contracting Parties are obliged to assess habitats listed in the Annexes of the Habitats Directive. The HELCOM Contracting Parties that are also EU member states will get direct benefit in their reporting process for the MSFD from the assessment work of the Red List of habitats and biotopes.

3.2 Geographical cover

HELCOM HUB's system is a comprehensive tool for creating a more complete understanding of the distribution of biotopes in the Baltic Sea. In theory HELCOM HUB covers the entire Baltic Sea underwater area. The classification of Baltic Sea habitats and biotopes was developed based on environmental and biological data collected from the entire HELCOM Baltic Sea area.

Benthic biotopes on HELCOM HUB Level 5 give the most complete coverage for the Baltic Sea - at this level the classification is comprehensive. Level 5 is therefore suggested to be the main level for threat assessments, management measures and maritime spatial planning purposes.

Data were collected from several national databases and was complemented by the knowledge of the involved experts. Although data on the distribution of species is currently available, it often lacks information on substrate. Creating distribution maps for the entire Baltic Sea of the habitats and biotopes listed in the classification system is thus not yet possible. The geographical coverage of the data compiled for the development of HELCOM HUB is relatively good. Data were available for many different biotopes, ranging from deep areas to shallow, from northern areas to southern and for some of the different substrate types associated with the biotic data.

It is possible that some rare biotopes have not been included and that all dominance defined biotopes might not have been identified, such as the Level 5 shell gravel biotopes that were represented by few or no samples. In this sense, the Level 6 biotopes that include rather specific taxonomical details are not complete at this time. Currently, it would not be possible to cover the entire HELCOM area using only biotopes defined at Level 6. Additions to Level 6 can be made in future classification revisions.

3.3 Ecological relevance

The ecological relevance on HELCOM HUB is dependent on the ecological relevance of the split rules. HELCOM HUB would not be ecologically relevant if the biotopes that are defined by the split rules could not be found in nature. Recalling the definition of a biotope, the biotope must also exhibit a distinct biotope function. The ecological relevance of HELCOM HUB thus also depends upon the communities defined on Levels 5 and 6 that have some distinct biotope forming function.

Verifying the occurrence of communities defined by the split rule in the compiled biological data was an important measure to ensure the ecological relevance of HELCOM HUB. The composition of communities was studied and the relevance of the 10% and 50% dominance cut-off values was tested and found to be relevant. Whether the community performed a distinct biotope forming function was not clear in every case. However, biotopes were not formed only based on the dominance of a species in a community if it was known that the species does not perform any biotope forming function.

The split rules and the biotopes they produce should be re-evaluated as more information on the distribution and function of Baltic Sea biotopes becomes available. A better understanding of the biotope functions performed by the communities of different species is needed. The ecological relevance of HELCOM HUB should be reaffirmed in future revisions of the classification.

HELCOM HUB largely covers all the ecological units and different communities in the Baltic Sea. Biotopes from the benthic and pelagic environments are covered and through the habitat complexes some of the coastal semi-terrestrial biotopes are also included. The classification also covers the major functional groups of the Baltic Sea biota. When the classification is used, it is important to be able to separate, for example, annual and perennial filamentous algae and which invertebrate species are epifaunal or opportunistic.

When using HELCOM HUB, information on taxonomy can be used from the HELCOM Checklist of Baltic Sea Macro-species (HELCOM 2012). In future revisions of the checklist, it would be beneficial to include information on which functional groups the species belong to, whether the species is annual or perennial and whether it lives on the substrate surface or in the substrate. This would support the classification of biological data using HELCOM HUB.

3.4 Advice for mapping biotopes

The Red List project accumulated information and experience on delineating benthic biotopes in a classification system that has previously not been compiled in a single process in the Baltic Sea region. From this experience, the project gives certain recommendations for mapping procedures of underwater habitats and biotopes that are of importance when HELCOM HUB is later used as a classification tool.

To apply the data smoothly to HELCOM HUB, it is recommended that continuous scales are used as opposed to discrete classes. Cover should be estimated as 9%, 53%, etc., as opposed to predetermined classes such as 10%, 50%, etc. Using a continuous scale will decrease the chance of two groups having the exact same cover value, which causes problems in the classification split rules on Levels 5 and 6 where dominance is to be determined.

No single sample constitutes a biotope. This implies that a 10x10 cm grab sample from soft sediment is not a biotope. It is recommended that several samples are taken from the same location in order to classify a biotope correctly. If the area that is sampled is very homogenous, it may be enough with a single sample (e.g. to classify a location within the deep anoxic bottom); however, if the area in question is heterogenous with varying substrates and diverse organism communities, several samples are needed to correctly identify the different biotopes.

When determining the depth of the photic zone, the depth should be estimated from a long-term growth season average of Secchi depth. One measurement should not be used in isolation from the previous measurement when determining the depth of the photic zone and applying the HELCOM HUB split rule. The absence of foliose vegetation can be used as a supporting measurement value for the depth of the photic zone. Even so, it is recommended that Secchi depth is measured during field sampling to support, validate and collect additional data on water turbidity and the effect on the distribution of biotopes.

It is recommended to sample infaunal communities quantitatively by using, for instance, the Manual for Marine Monitoring in the HELCOM COMBINE programme (available on the HELCOM website). When sampling epibenthic communities it is suggested to apply visual techniques. To estimate coverage and height of the epibenthic organisms, SCUBA divers

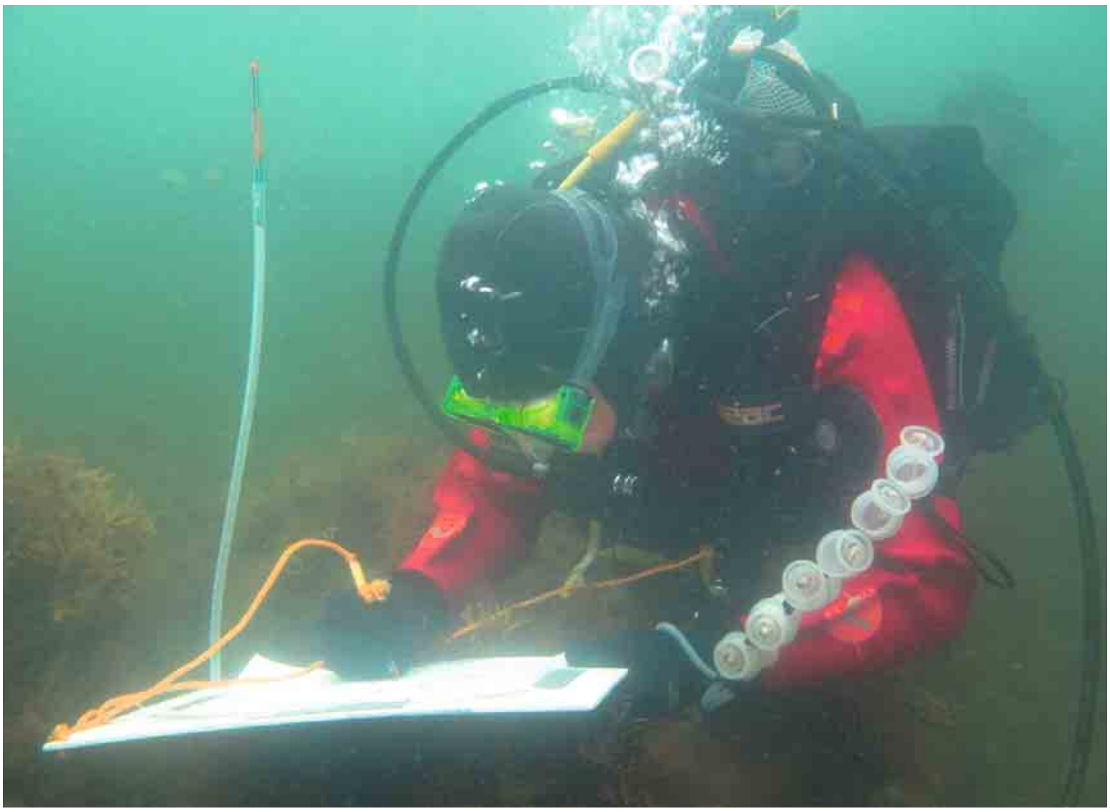


Figure 22. Divers estimating vegetation coverage are recommended to use a continuous scale. Photo: Metsähallitus NHS/Ulrika Björkman

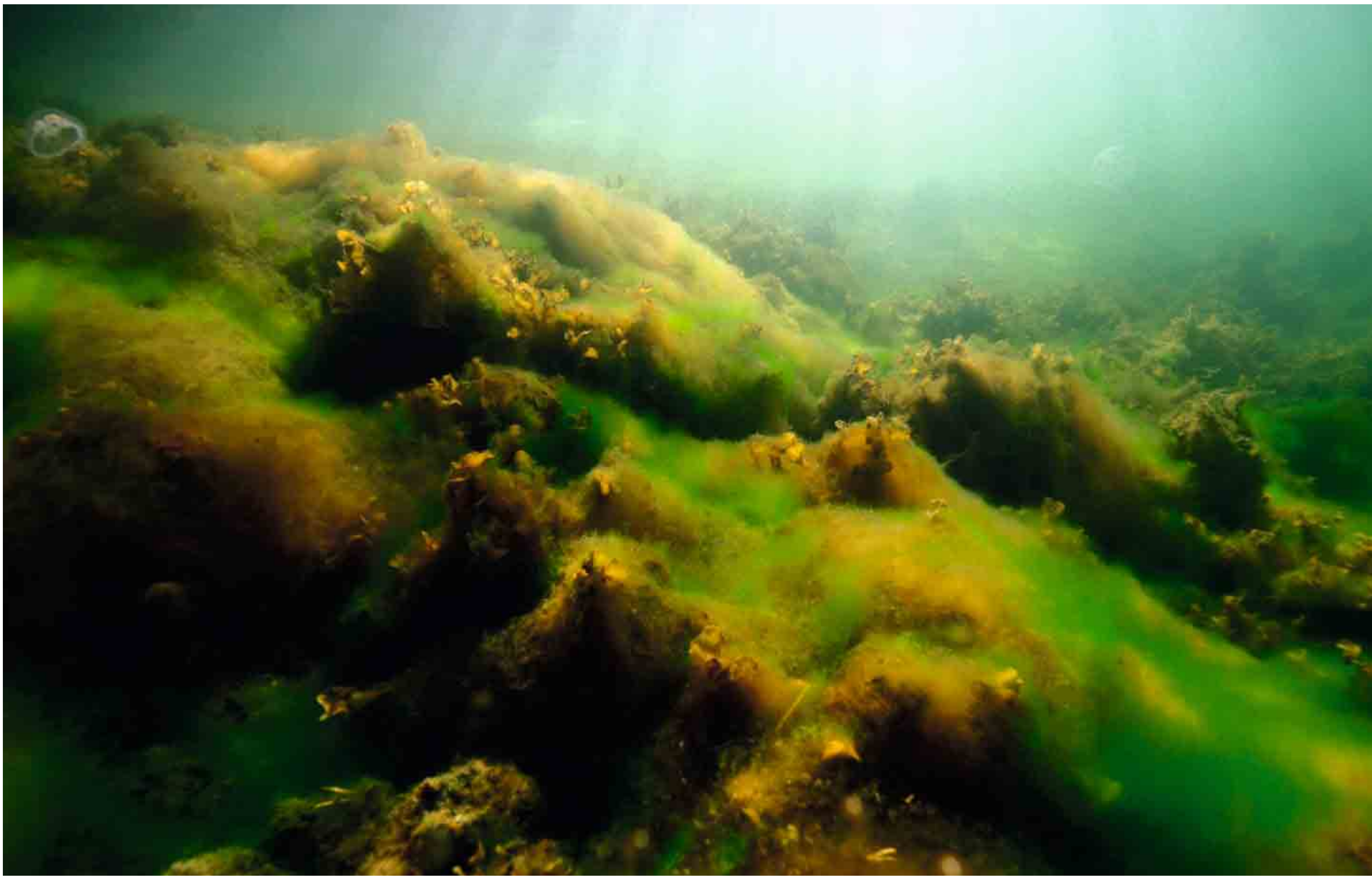


Figure 23. The coverage of annual algae on perennial algae is considered to be a quality indicator of the perennial biotope. Metsähallitus NHS/Mats Westerbom

or Remotely Operated Vehicle (ROV) techniques can be used. Whenever possible, it is recommended that both visual techniques and quantitative grab samples are taken, especially when an area is mapped for the first time. For instance, as the biotope *Baltic aphotic muddy sediment dominated by sea pens* (AB.H2T1) mainly occurs in areas where infauna biotopes are common, it may seem appropriate to only use infaunal sampling techniques. However, a correct classification of the seapen biotope requires visual sampling methods since the characteristic species might not be found when sampling methods designed for infauna are applied. If the occurrence of the biotope in the area was not known previously, it might not be identified if the area was only sampled with techniques designed for infauna.

HELCOM HUB utilises biovolume in the split rule on Levels 5 and 6 for biotopes characterised by vegetation. In order for the biovolume measurement to be relevant, average height values of the vegetation species should always be collected when sampling. Using regional height values supported by the literature is the second best option when determining biovolume. However, it is recommended to use actual measurements from the sampling site since the average height of a plant species can vary significantly even within a region. For instance bladderwrack (*Fucus vesiculosus)* is well known to grow higher in protected bays compared to exposed shores, and the difference in size may vary significantly within a short distance. If previously sampled data are to be classified but do not include height measurements or there are no regional height measurements that can be applied to the data, then the measurements from the Finnish coast can be applied as the last option to classify the biotope down to Level 6 (Annex 3).

The coverage of perennial vegetation may vary during the productive season. The effect of seasonal timing of sampling is highlighted when coverage of annual algae is used as a biotope delineating factor. Optimally, mapping should take place during the months when the vegetation community is fully developed. When estimating the vegetation coverage, the split rules should be applied to the average, fully developed community. The classification system has not been designed in a way where the user would have to follow split rules defining the sampling time in order to classify a biotope on Levels 5–6. While this kind of split would have made the classification more robust, it would increase the number of the split rules that would have made HELCOM HUB less practical. It is stressed, therefore, that any HELCOM HUB classification of a biotope where vegetation is considered should be supported by expert judgement on the average size of the species. The vegetation data should be critically interpreted to verify that is representative of the average, fully developed vegetation community.

When sampling epibenthic communities and documenting the coverage of the various species, it is recommended to also note down the growth form. In HELCOM HUB, epiphytes are considered to be quality descriptors and not habitat forming. Moss animals and annual algae can live as epiphytes such as the moss animal *Electra crustulenta,* or annual algae *Pilayella/Ectocarpus* on the perennial algae *Fucus vesiculosus*. Moss animals, annual algae or other similar organisms are only considered to be biotope forming when they dominate the substrate and not when they grow on perennial biotic structures.

3.5 First user experiences of applying HELCOM HUB on a management scale

Metsähallitus' Natural Heritage Services in Finland applied HELCOM HUB to national monitoring data collected by drop-video in order to test how HELCOM HUB functions in practice. The data were collected, analysed and stored in an Excel table; the analysis of the biotopes was carried out by adding the split rules as mathematical equations to the table, e.g. if the depth is less than 10 m (photic zone) and the substrate is at least 90% sand and less than 10% is covered by vegetation or epibenthic fauna, then it classifies as a certain biotope.

By applying HELCOM HUB split rules to the drop-video data and visualising the classified biotopes on a map, the large scale biotope patterns were successfully mapped in the archipelago of the northernmost Gulf of Bothnia (Figure 24). The classification of the individual grid cells has not yet been verified, but it was clear that the classification successfully identifies relevant biotope patterns on a spatial scale that is important for environmental management.

3.6 HELCOM HUB online availability and descriptions of biotopes

Knowing if an area has been classified correctly can be difficult to determine if it is only based on the name of the biotope. More extensive textual descriptions of the distinctive features of the habitats and biotopes will facilitate the use of HELCOM HUB. The main purpose of the descriptions of biotopes is to provide information that helps the user to distinguishing the habitats/biotopes from their nearest neighbours. Visual material of the biotopes will be included from as many different locations as possible in order to illustrate the variability of the biotopes. The aim is to compile this information and make it available online through the HELCOM website together with other information relevant to the classification, such as information on potential updates of HELCOM HUB.

3.7 HELCOM HUB and its compatibility with EUNIS

As HELCOM HUB reflects major features of the Baltic ecosystem, it thus meets the needs of the Baltic region. HELCOM HUB has simultaneously been developed to enable the smooth transfer of the Baltic units to the European habitat classification system, EUNIS. HELCOM HUB, therefore, represents a compromise between an independent Baltic classification 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. Some adjustments to the information content of the split rules could be made at the higher levels in HELCOM HUB without chang-

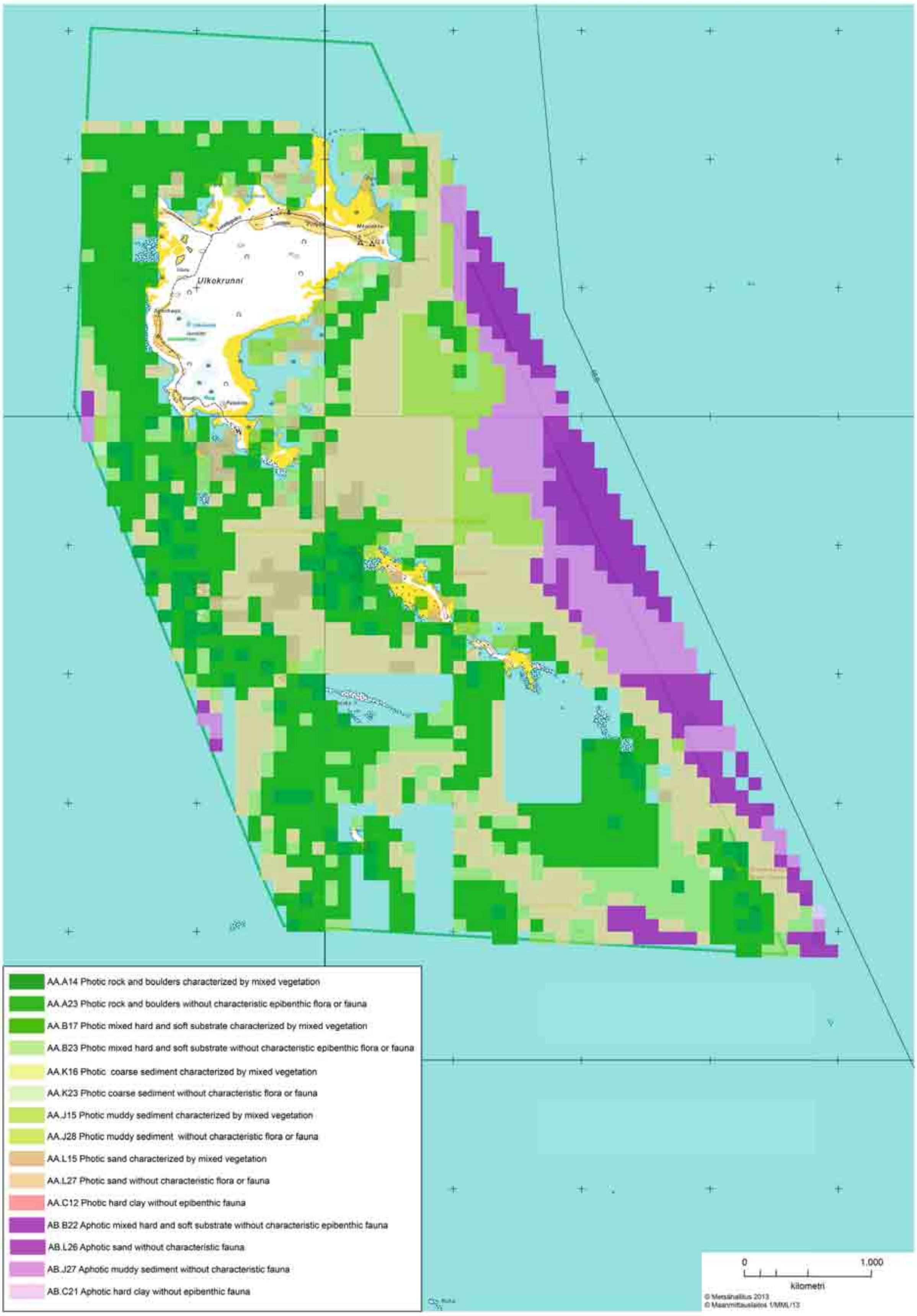


Figure 24. Metsähallitus Natural Heritage Services (Finland) applied the classification system to national monitoring GIS data. Note that the coding of the biotopes has changed in the final version of HELCOM HUB. (Courtesy of: Metsähallitus Natural Heritage Services, Finland)

ing the number of defined biotopes. For instance, salinity could be included by defining all Baltic Sea biotopes as <30 psu on HELCOM HUB Level 1, without splitting the Baltic into several different low salinity classes.

The attenuation of light is an important factor in the classification of the Baltic Sea habitats and biotopes. The division into the photic and non-photic habitats is, in principle, coherent with the division into the circa- and infralittoral zones; however, there is no final description of the circa- and infralittoral provided by the EEA for the EUNIS system. For this reason, it is not evident if the photic/aphotic can be reverted to the previous circa-/infralittoral in a way that they still represent photic/aphotic conditions which are highly relevant for the ecological structure of Baltic Sea biotopes. Contrary to tidal seas, inclusion of the littoral zone in the HELCOM HUB split is not relevant for biotopes in the non-tidal Baltic Sea.

Further testing of the broad-scale predictive EUNIS habitats will be carried out with biological data in the second phase of the EUSeaMap project 2013–2015. Through this process, the HELCOM HUB classification could be validated against the Baltic Sea habitat maps developed in the project. This type of validation is especially important for the biotopes that only occur in the Kattegat and most closely resemble marine biotopes described in other classifications. The EUNIS system currently covers the Kattegat, but at a cruder level than HELCOM HUB. The Kattegat HELCOM HUB classification was made on the basis of biological data with only few biotopes added based on expert judgement. The inclusion of Kattegat biotopes was thus not made in a manner fully consistent with the rest of the Baltic Sea. It is especially recommended that the Kattegat biotopes, especially in Danish waters, will be re-considered when the North Sea EUNIS is revised in the future.

3.8 Limitations of the HELCOM HUB classification system

Any classification scheme is merely a schematic representation of the natural environment. HELCOM HUB split rules define discrete cut-off values for abiotic environmental gradients and biotic communities that more closely resemble continuums in nature. Analyses of the available biological data supported the identified discrete cut-off values; however, it is possible that some adjustments to the cut-off values will be called for when more information on the biotopes and their function becomes available.

Two areas that appear different in nature may be classified as the same biotope in HELCOM HUB since dominance is used in the split rules on Levels 5 and 6. Dominance is a relative comparison. On Level 5, for instance, an area will be classified as *characterised by perennial algae* if the highest coverage exhibited by any group is that of perennial algae with a coverage of 15%. Another area can be classified as the same biotope *characterised by perennial algae* if the coverage of perennial algae is 90% and no other group has a higher dominance. Even though these areas might appear different in nature, they are classified as the same biotope on Level 5. Likewise, two areas that can appear similar in the field may be classified as different biotopes if the dominance differs. On Level 5, for example, an area will be classified as *characterised by perennial algae* if the coverage of perennial algae is 55% and the coverage of submerged rooted plants is 50%. If, on the other hand, submerged rooted plants exhibit a coverage of 55% and the perennial algae exhibit a coverage of 50%, then the biotope will be classified as cha*racterised by submerged rooted plants*. In most cases, this approach will not cause problems; however, HELCOM HUB users should be aware of the implication of this inherent mechanism in the split rules that defines the biotope by the most dominant group.

The lack of comprehensive and long-term data may have caused some habitats and biotopes to be misclassified in the data analysis. Even though several of the Baltic Sea coastal countries have developed national biotope classification schemes and conducted various scientific surveys and mapping projects, data sets of all the environmental factors connected to communities are not comprehensive. There is also a strong regional variation, where some areas of the Baltic Sea are intensely studied and very little is known of the biotopes in other regions. Currently, most of the national sampling programmes are designed for monitoring eutrophication and pollution status. As samples are gathered from the same point every year, these data are not well suited for mapping and classifying biotopes since only specific biotopes are sampled; for example, infauna monitoring data from Swedish and Finnish marine area sampled nearly exclusively muddy sediment, which does not support the work of delineating biotopes characterised by infauna on other substrate types. Substrate descriptions, in particular, varied greatly between countries regarding accuracy and definitions. The currently available substrate maps for the Baltic Sea may be problematic to use as they are of poor quality, especially in shallow areas, meaning that resulting large-scale maps of biotopes based on these will also be of poor quality.

The level of taxonomic resolution in the sampling programmes varies between countries. Moreover, different grabs as well as sieve sizes have had a negative effect on the unity of the compiled zoobenthos data. The scale of sampling zoobenthic communities is very small from a biotope perspective. In theory, the different methods used for sampling does not affect the result when the BalMar tool is used since it classifies each sample separately. Thus, the result is not dependent on other data, which is the case in ordination or cluster-based methods where this dependency constitutes the major weakness of the methods. The difference is most pronounced when analysing datasets where several samples contain several species. However, the differences in sampling techniques can create difficulties in delineating natural clusters; moreover, artificial clusters might be formed due to natural variation in the samples if patchiness or a small sampling area results in an absence of species in several of the samples.

Depending on whether phytobenthos was estimated using biovolume, biomass or coverage, the result will differ somewhat when the data records are classified (Kiirikki et al. 1998). Different species densities and human factors that affect all estimations are probable causes for the varying results. Coverage estimates are generally made by observing an area of 1–6 m^2, while biomass samples are collected from a much smaller area, typically 0.04 m^2. Since biomass data from phytobenthos are less abundant than coverage estimates, coverage estimate data are preferable for phytobenthos classification. Biomass can be used for estimating the dominating plant species; however, these kind of data are rare and not necessarily comparable with the coverage estimate data.

4 HELCOM HUB Flowchart

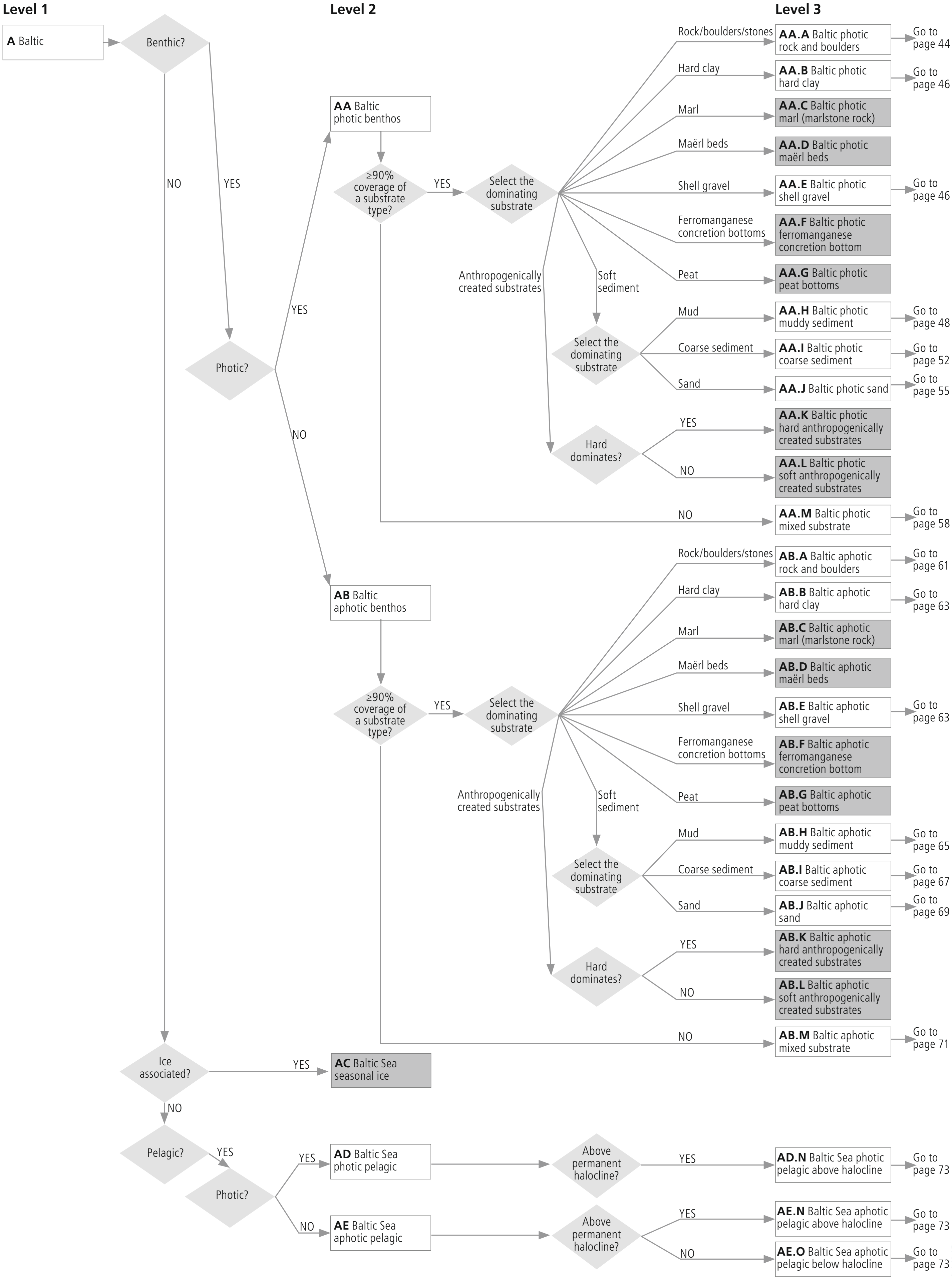
HELCOM HUB is a hierarchical classification system that delineates biotopes using split rules. The classification utilizes six levels. The flowchart on the following pages describes the entire classification system, including all habitats, biotopes and split rules recognized in HELCOM HUB. The structure of the code preceding the name of the biotope is explained in Table 4 on page 74**.**

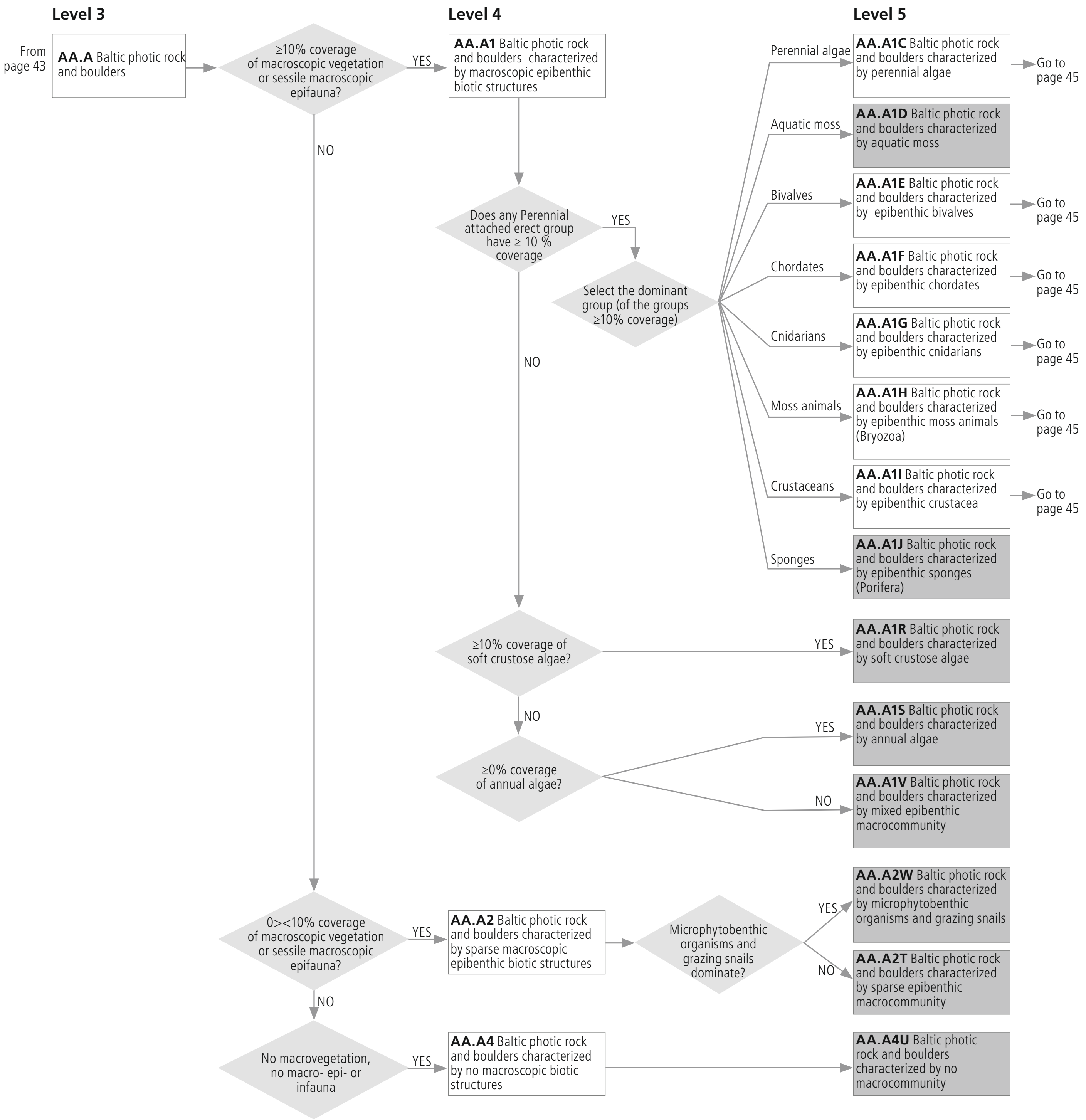
Biotopes and habitats are symbolized by rectangles in the flowchart. A grey coloured rectangle indicates that no lower level biotope exists. A grey rectangle should always be reached whenever data is classified using the flow chart, except in the cases when the data is classified as a Level 5 biotope even though lower Level 6 biotopes exist. Split rules cannot be disregarded in order to reach the next level.

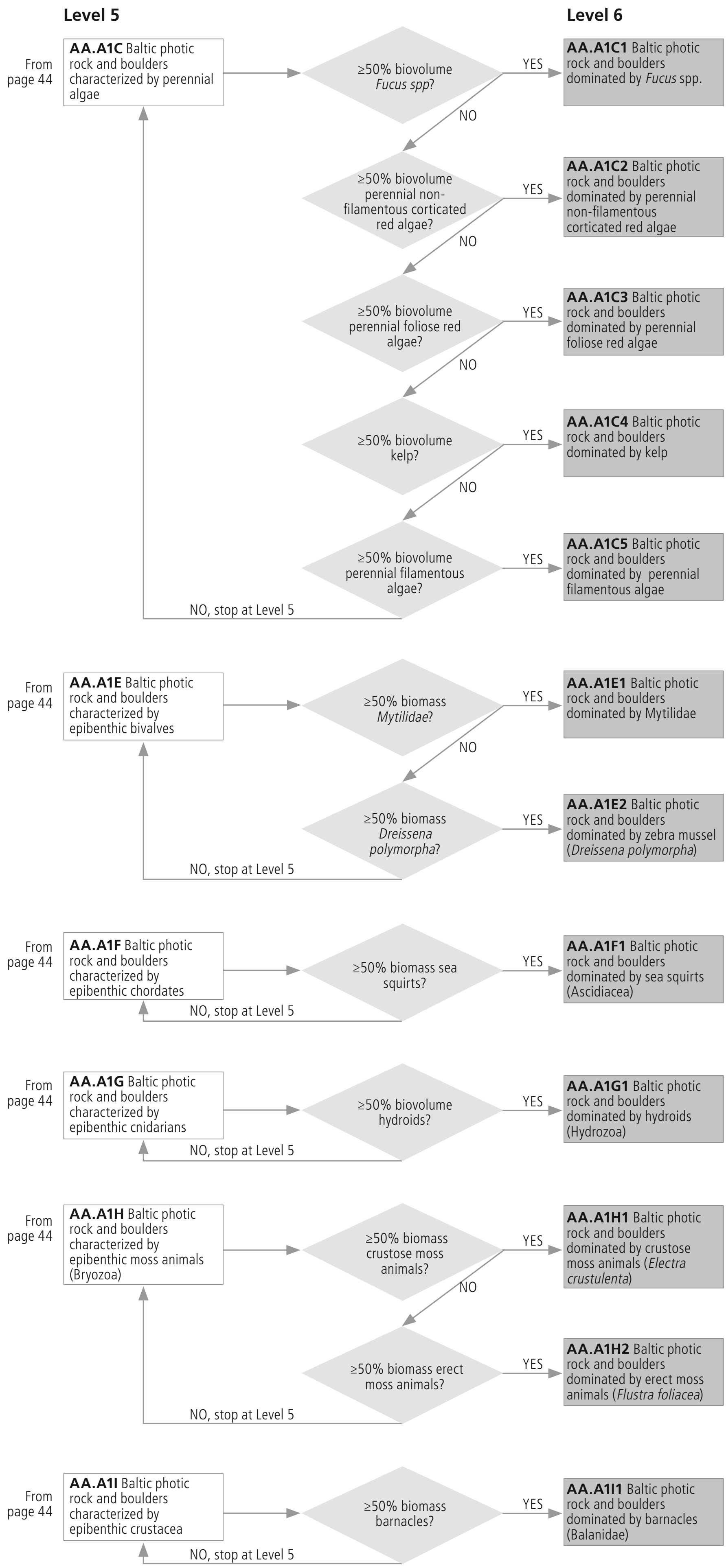
Split rules are symbolized by light grey coloured diamond shapes. The split rules are generally expressed as questions. The selection of the arrow to follow to the next level of biotopes depends on the outcome of the question in the split rule.

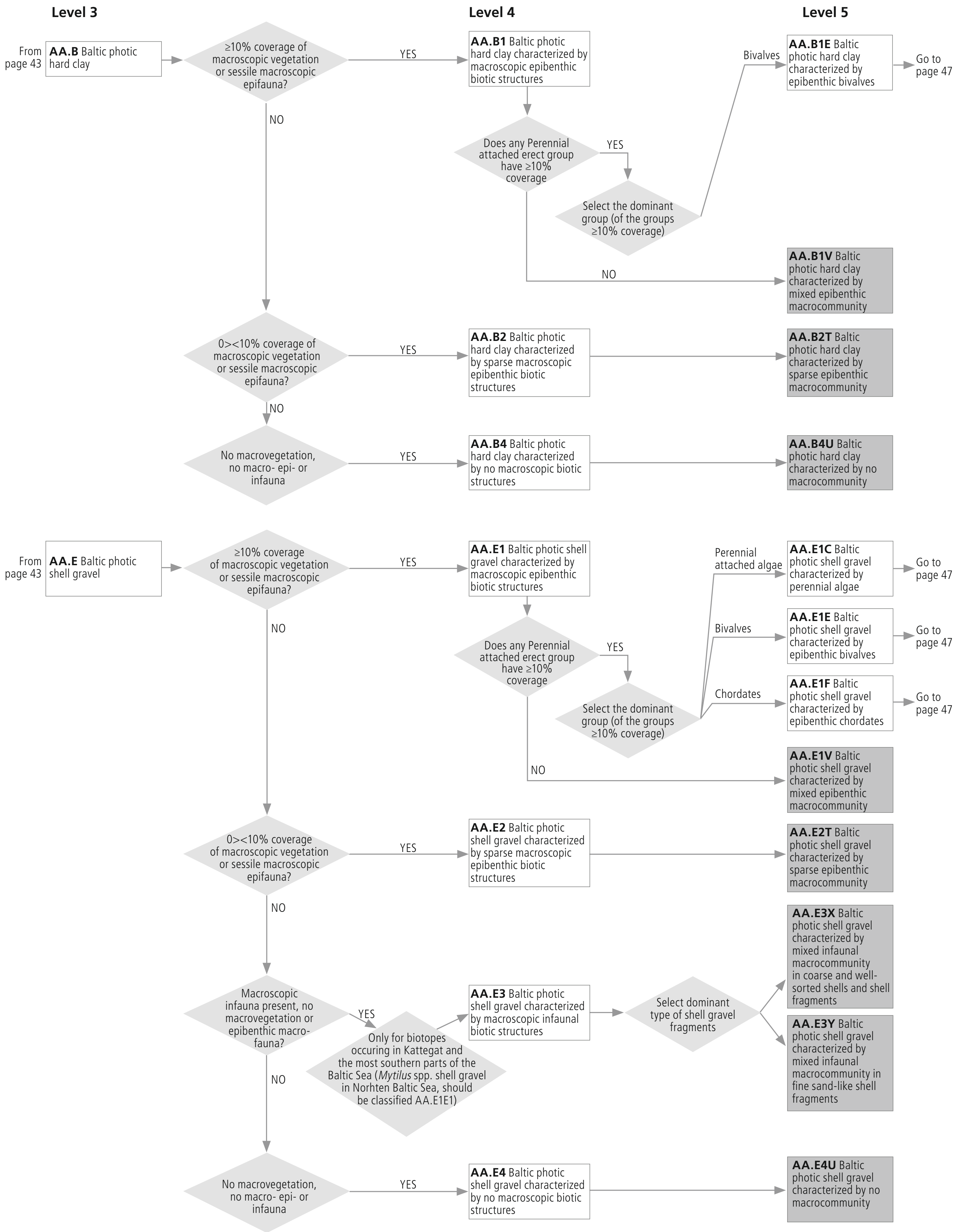
The first page of the flowchart displays habitats and split rules from Level 1 to Level 3. Consecutive pages systematically describe the Level 3 – Level 5 and Level 5 – Level 6 splits for all biotopes in the order the biotopes are described on the first page. This implies that the habitat *'AA.A Baltic photic rock and boulder'* and all the biotopes defined by photic rock on Level 4 – Level 6 are first described, and only after this the biotopes under the Level 3 habitat *'AA.B Baltic photic hard clay'* are described.

Figure 25. Data gathered in the field can be classified into biotopes using the HELCOM HUB. Photo: Metsähallitus NHS /Anna Soirinsuo

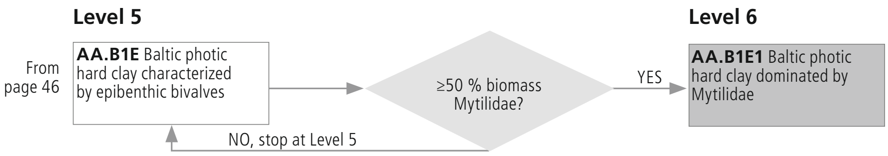

Level 1
Level 2
Level 3
A Baltic
Benthic?
NO
YES
Photic?
YES
NO
AA Baltic photic benthos
≥90% coverage of a substrate type?
YES
Select the dominating substrate
Rock/boulders/stones
AA.A Baltic photic rock and boulders
Go to page 44
Hard clay
AA.B Baltic photic hard clay
Go to page 46
Marl
AA.C Baltic photic marl (marlstone rock)
Maërl beds
AA.D Baltic photic maërl beds
Shell gravel
AA.E Baltic photic shell gravel
Go to page 46
Ferromanganese concretion bottoms
AA.F Baltic photic ferromanganese concretion bottom
Peat
AA.G Baltic photic peat bottoms
Anthropogenically created substrates
Soft sediment
Select the dominating substrate
Mud
AA.H Baltic photic muddy sediment
Go to page 48
Coarse sediment
AA.I Baltic photic coarse sediment
Go to page 52
Sand
AA.J Baltic photic sand
Go to page 55
Hard dominates?
YES
AA.K Baltic photic hard anthropogenically created substrates
NO
AA.L Baltic photic soft anthropogenically created substrates
NO
AA.M Baltic photic mixed substrate
Go to page 58
AB Baltic aphotic benthos
≥90% coverage of a substrate type?
YES
Select the dominating substrate
Rock/boulders/stones
AB.A Baltic aphotic rock and boulders
Go to page 61
Hard clay
AB.B Baltic aphotic hard clay
Go to page 63
Marl
AB.C Baltic aphotic marl (marlstone rock)
Maërl beds
AB.D Baltic aphotic maërl beds
Shell gravel
AB.E Baltic aphotic shell gravel
Go to page 63
Ferromanganese concretion bottoms
AB.F Baltic aphotic ferromanganese concretion bottom
Peat
AB.G Baltic aphotic peat bottoms
Anthropogenically created substrates
Soft sediment
Select the dominating substrate
Mud
AB.H Baltic aphotic muddy sediment
Go to page 65
Coarse sediment
AB.I Baltic aphotic coarse sediment
Go to page 67
Sand
AB.J Baltic aphotic sand
Go to page 69
Hard dominates?
YES
AB.K Baltic aphotic hard anthropogenically created substrates
NO
AB.L Baltic aphotic soft anthropogenically created substrates
NO
AB.M Baltic aphotic mixed substrate
Go to page 71
Ice associated?
YES
AC Baltic Sea seasonal ice
NO
Pelagic?
YES
Photic?
YES
AD Baltic Sea photic pelagic
Above permanent halocline?
YES
AD.N Baltic Sea photic pelagic above halocline
Go to page 73
NO
AE Baltic Sea aphotic pelagic
Above permanent halocline?
YES
AE.N Baltic Sea aphotic pelagic above halocline
Go to page 73
NO
AE.O Baltic Sea aphotic pelagic below halocline
Go to page 73

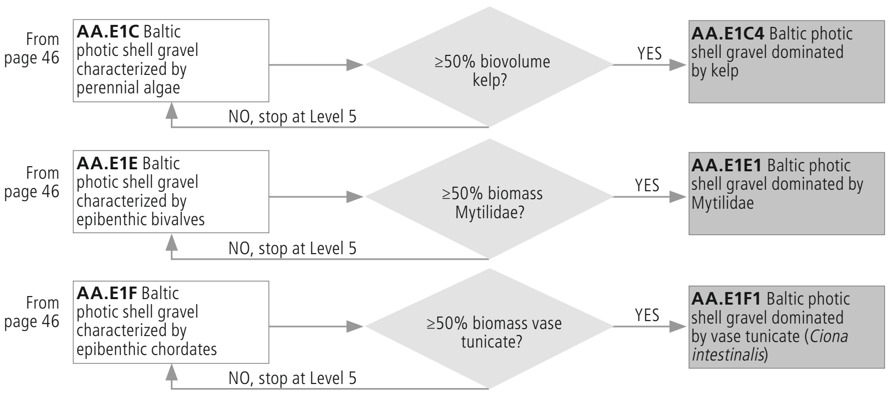

Level 3
Level 4
Level 5
From page 43
AA.A Baltic photic rock and boulders
≥10% coverage of macroscopic vegetation or sessile macroscopic epifauna?
YES
NO
AA.A1 Baltic photic rock and boulders characterized by macroscopic epibenthic biotic structures
Does any Perennial attached erect group have ≥ 10 % coverage
YES
NO
Select the dominant group (of the groups ≥10% coverage)
Perennial algae
AA.A1C Baltic photic rock and boulders characterized by perennial algae
Go to page 45
Aquatic moss
AA.A1D Baltic photic rock and boulders characterized by aquatic moss
Bivalves
AA.A1E Baltic photic rock and boulders characterized by epibenthic bivalves
Go to page 45
Chordates
AA.A1F Baltic photic rock and boulders characterized by epibenthic chordates
Go to page 45
Cnidarians
AA.A1G Baltic photic rock and boulders characterized by epibenthic cnidarians
Go to page 45
Moss animals
AA.A1H Baltic photic rock and boulders characterized by epibenthic moss animals (Bryozoa)
Go to page 45
Crustaceans
AA.A1I Baltic photic rock and boulders characterized by epibenthic crustacea
Go to page 45
Sponges
AA.A1J Baltic photic rock and boulders characterized by epibenthic sponges (Porifera)
≥10% coverage of soft crustose algae?
YES
AA.A1R Baltic photic rock and boulders characterized by soft crustose algae
NO
≥0% coverage of annual algae?
YES
AA.A1S Baltic photic rock and boulders characterized by annual algae
NO
AA.A1V Baltic photic rock and boulders characterized by mixed epibenthic macrocommunity
0><10% coverage of macroscopic vegetation or sessile macroscopic epifauna?
YES
AA.A2 Baltic photic rock and boulders characterized by sparse macroscopic epibenthic biotic structures
Microphytobenthic organisms and grazing snails dominate?
YES
AA.A2W Baltic photic rock and boulders characterized by microphytobenthic organisms and grazing snails
NO
AA.A2T Baltic photic rock and boulders characterized by sparse epibenthic macrocommunity
NO
No macrovegetation, no macro- epi- or infauna
YES
AA.A4 Baltic photic rock and boulders characterized by no macroscopic biotic structures
AA.A4U Baltic photic rock and boulders characterized by no macrocommunity

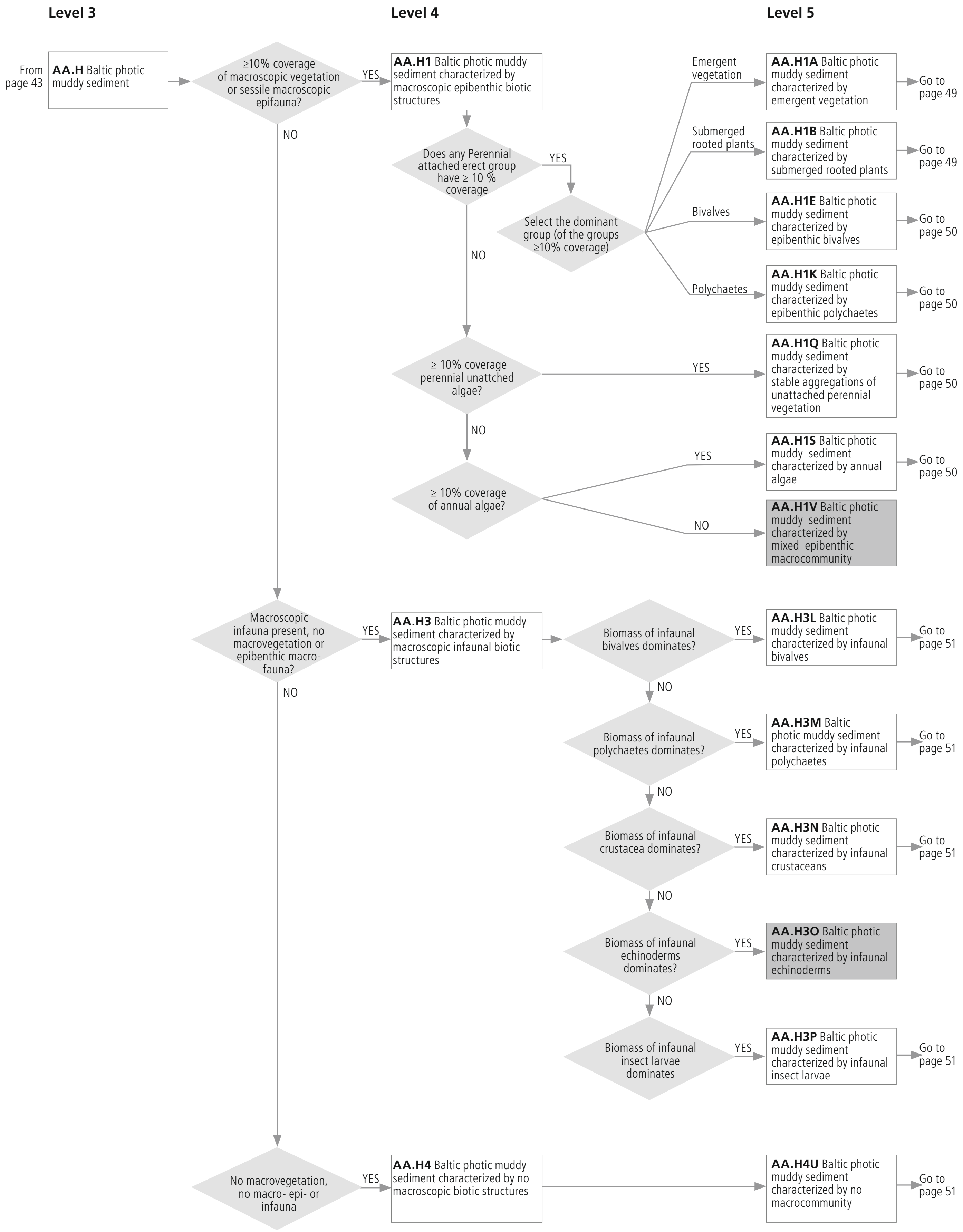

Level 5
Level 6
From page 44
AA.A1C Baltic photic rock and boulders characterized by perennial algae
≥50% biovolume Fucus spp?
YES
AA.A1C1 Baltic photic rock and boulders dominated by Fucus spp.
NO
≥50% biovolume perennial non-filamentous corticated red algae?
YES
AA.A1C2 Baltic photic rock and boulders dominated by perennial non-filamentous corticated red algae
NO
≥50% biovolume perennial foliose red algae?
YES
AA.A1C3 Baltic photic rock and boulders dominated by perennial foliose red algae
NO
≥50% biovolume kelp?
YES
AA.A1C4 Baltic photic rock and boulders dominated by kelp
NO
≥50% biovolume perennial filamentous algae?
YES
AA.A1C5 Baltic photic rock and boulders dominated by perennial filamentous algae
NO, stop at Level 5
From page 44
AA.A1E Baltic photic rock and boulders characterized by epibenthic bivalves
≥50% biomass Mytilidae?
YES
AA.A1E1 Baltic photic rock and boulders dominated by Mytilidae
NO
≥50% biomass Dreissena polymorpha?
YES
AA.A1E2 Baltic photic rock and boulders dominated by zebra mussel (Dreissena polymorpha)
NO, stop at Level 5
From page 44
AA.A1F Baltic photic rock and boulders characterized by epibenthic chordates
≥50% biomass sea squirts?
YES
AA.A1F1 Baltic photic rock and boulders dominated by sea squirts (Ascidiacea)
NO, stop at Level 5
From page 44
AA.A1G Baltic photic rock and boulders characterized by epibenthic cnidarians
≥50% biovolume hydroids?
YES
AA.A1G1 Baltic photic rock and boulders dominated by hydroids (Hydrozoa)
NO, stop at Level 5
From page 44
AA.A1H Baltic photic rock and boulders characterized by epibenthic moss animals (Bryozoa)
≥50% biomass crustose moss animals?
YES
AA.A1H1 Baltic photic rock and boulders dominated by crustose moss animals (Electra crustulenta)
NO
≥50% biomass erect moss animals?
YES
AA.A1H2 Baltic photic rock and boulders dominated by erect moss animals (Flustra foliacea)
NO, stop at Level 5
From page 44
AA.A1I Baltic photic rock and boulders characterized by epibenthic crustacea
≥50% biomass barnacles?
YES
AA.A1I1 Baltic photic rock and boulders dominated by barnacles (Balanidae)
NO, stop at Level 5



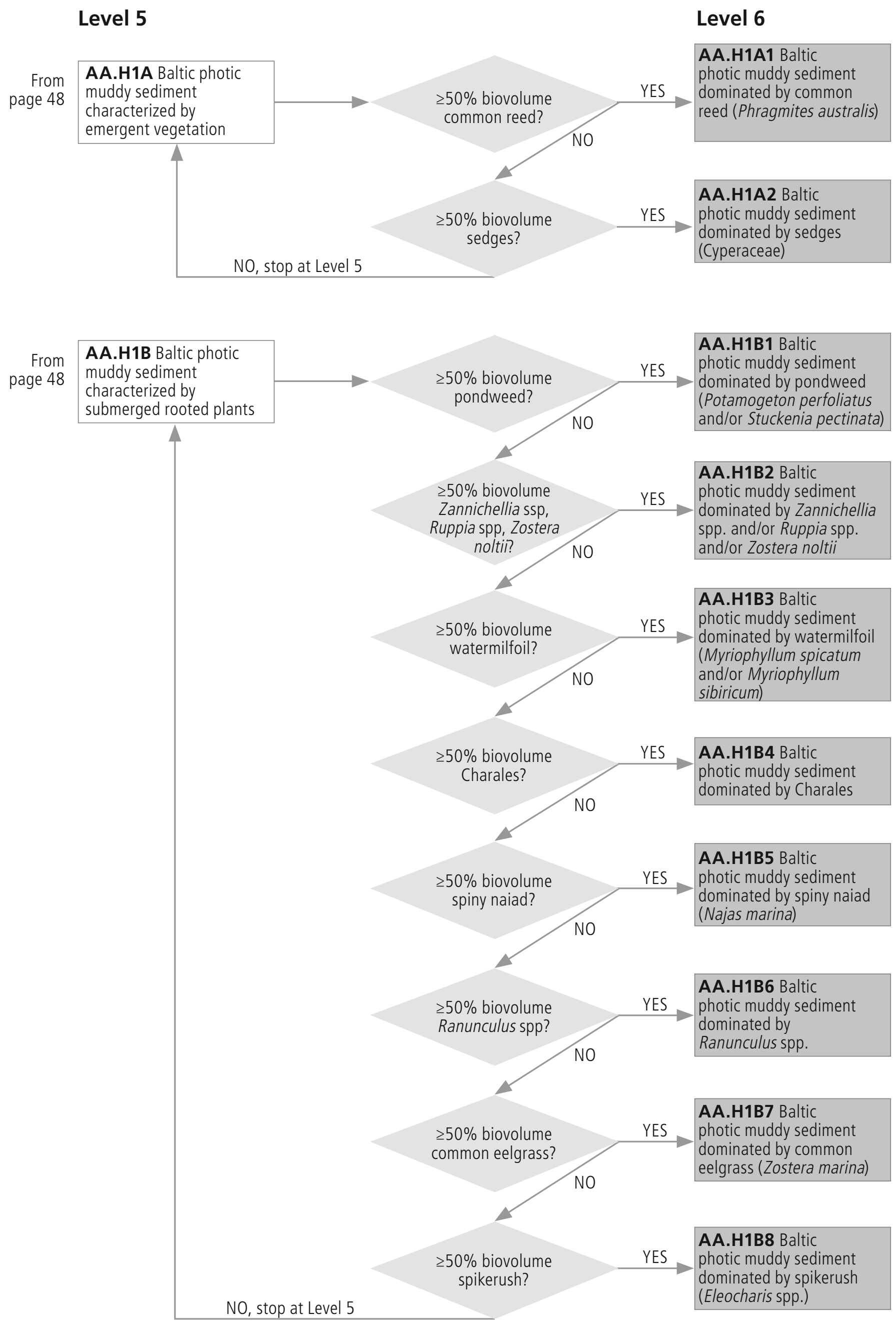
Level 3
Level 4
Level 5
From page 43
AA.B Baltic photic hard clay
≥10% coverage of macroscopic vegetation or sessile macroscopic epifauna?
YES
AA.B1 Baltic photic hard clay characterized by macroscopic epibenthic biotic structures
Does any Perennial attached erect group have ≥10% coverage
YES
Select the dominant group (of the groups ≥10% coverage)
Bivalves
AA.B1E Baltic photic hard clay characterized by epibenthic bivalves
Go to page 47
NO
AA.B1V Baltic photic hard clay characterized by mixed epibenthic macrocommunity
NO
0><10% coverage of macroscopic vegetation or sessile macroscopic epifauna?
YES
AA.B2 Baltic photic hard clay characterized by sparse macroscopic epibenthic biotic structures
AA.B2T Baltic photic hard clay characterized by sparse epibenthic macrocommunity
NO
No macrovegetation, no macro- epi- or infauna
YES
AA.B4 Baltic photic hard clay characterized by no macroscopic biotic structures
AA.B4U Baltic photic hard clay characterized by no macrocommunity
From page 43
AA.E Baltic photic shell gravel
≥10% coverage of macroscopic vegetation or sessile macroscopic epifauna?
YES
AA.E1 Baltic photic shell gravel characterized by macroscopic epibenthic biotic structures
Does any Perennial attached erect group have ≥10% coverage
YES
Select the dominant group (of the groups ≥10% coverage)
Perennial attached algae
AA.E1C Baltic photic shell gravel characterized by perennial algae
Go to page 47
Bivalves
AA.E1E Baltic photic shell gravel characterized by epibenthic bivalves
Go to page 47
Chordates
AA.E1F Baltic photic shell gravel characterized by epibenthic chordates
Go to page 47
NO
AA.E1V Baltic photic shell gravel characterized by mixed epibenthic macrocommunity
NO
0><10% coverage of macroscopic vegetation or sessile macroscopic epifauna?
YES
AA.E2 Baltic photic shell gravel characterized by sparse macroscopic epibenthic biotic structures
AA.E2T Baltic photic shell gravel characterized by sparse epibenthic macrocommunity
NO
Macroscopic infauna present, no macrovegetation or epibenthic macro-fauna?
YES
Only for biotopes occuring in Kattegat and the most southern parts of the Baltic Sea (Mytilus spp. shell gravel in Norhten Baltic Sea, should be classified AA.E1E1)
AA.E3 Baltic photic shell gravel characterized by macroscopic infaunal biotic structures
Select dominant type of shell gravel fragments
AA.E3X Baltic photic shell gravel characterized by mixed infaunal macrocommunity in coarse and well-sorted shells and shell fragments
AA.E3Y Baltic photic shell gravel characterized by mixed infaunal macrocommunity in fine sand-like shell fragments
NO
No macrovegetation, no macro- epi- or infauna
YES
AA.E4 Baltic photic shell gravel characterized by no macroscopic biotic structures
AA.E4U Baltic photic shell gravel characterized by no macrocommunity


Level 5
Level 6
From page 46
AA.B1E Baltic photic hard clay characterized by epibenthic bivalves
≥50 % biomass Mytilidae?
YES
AA.B1E1 Baltic photic hard clay dominated by Mytilidae
NO, stop at Level 5

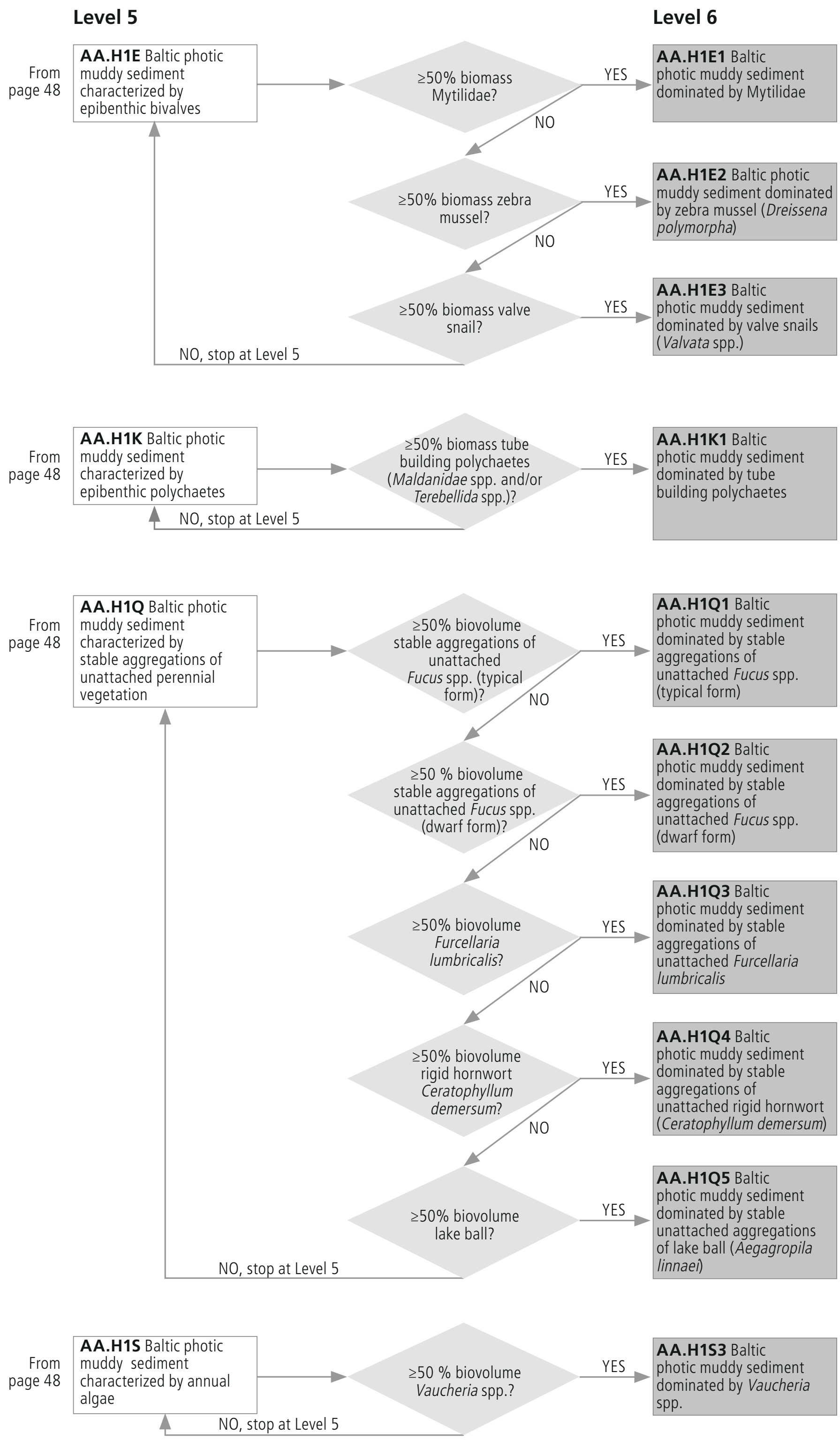

From page 46
AA.E1C Baltic photic shell gravel characterized by perennial algae
≥50% biovolume kelp?
YES
AA.E1C4 Baltic photic shell gravel dominated by kelp
NO, stop at Level 5
From page 46
AA.E1E Baltic photic shell gravel characterized by epibenthic bivalves
≥50% biomass Mytilidae?
YES
AA.E1E1 Baltic photic shell gravel dominated by Mytilidae
NO, stop at Level 5
From page 46
AA.E1F Baltic photic shell gravel characterized by epibenthic chordates
≥50% biomass vase tunicate?
YES
AA.E1F1 Baltic photic shell gravel dominated by vase tunicate (Ciona intestinalis)
NO, stop at Level 5



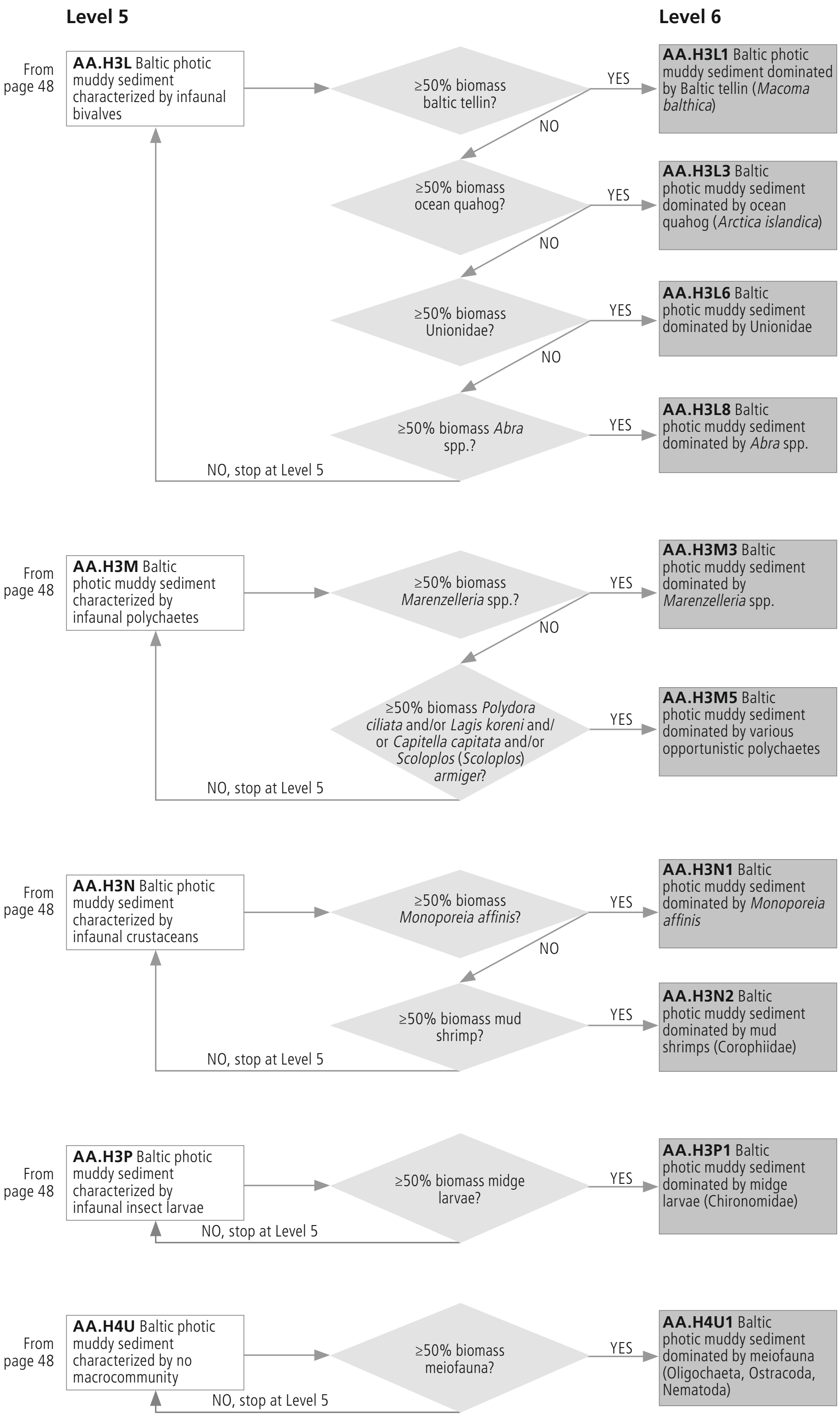
Level 3
Level 4
Level 5
From page 43
AA.H Baltic photic muddy sediment
≥10% coverage of macroscopic vegetation or sessile macroscopic epifauna?
YES
NO
AA.H1 Baltic photic muddy sediment characterized by macroscopic epibenthic biotic structures
Does any Perennial attached erect group have ≥ 10 % coverage
YES
NO
Select the dominant group (of the groups ≥10% coverage)
Emergent vegetation
Submerged rooted plants
Bivalves
Polychaetes
AA.H1A Baltic photic muddy sediment characterized by emergent vegetation
Go to page 49
AA.H1B Baltic photic muddy sediment characterized by submerged rooted plants
Go to page 49
AA.H1E Baltic photic muddy sediment characterized by epibenthic bivalves
Go to page 50
AA.H1K Baltic photic muddy sediment characterized by epibenthic polychaetes
Go to page 50
≥ 10% coverage perennial unattched algae?
YES
NO
AA.H1Q Baltic photic muddy sediment characterized by stable aggregations of unattached perennial vegetation
Go to page 50
≥ 10% coverage of annual algae?
YES
NO
AA.H1S Baltic photic muddy sediment characterized by annual algae
Go to page 50
AA.H1V Baltic photic muddy sediment characterized by mixed epibenthic macrocommunity
Macroscopic infauna present, no macrovegetation or epibenthic macro-fauna?
YES
NO
AA.H3 Baltic photic muddy sediment characterized by macroscopic infaunal biotic structures
Biomass of infaunal bivalves dominates?
YES
NO
AA.H3L Baltic photic muddy sediment characterized by infaunal bivalves
Go to page 51
Biomass of infaunal polychaetes dominates?
YES
NO
AA.H3M Baltic photic muddy sediment characterized by infaunal polychaetes
Go to page 51
Biomass of infaunal crustacea dominates?
YES
NO
AA.H3N Baltic photic muddy sediment characterized by infaunal crustaceans
Go to page 51
Biomass of infaunal echinoderms dominates?
YES
NO
AA.H3O Baltic photic muddy sediment characterized by infaunal echinoderms
Biomass of infaunal insect larvae dominates
YES
AA.H3P Baltic photic muddy sediment characterized by infaunal insect larvae
Go to page 51
No macrovegetation, no macro- epi- or infauna
YES
AA.H4 Baltic photic muddy sediment characterized by no macroscopic biotic structures
AA.H4U Baltic photic muddy sediment characterized by no macrocommunity
Go to page 51



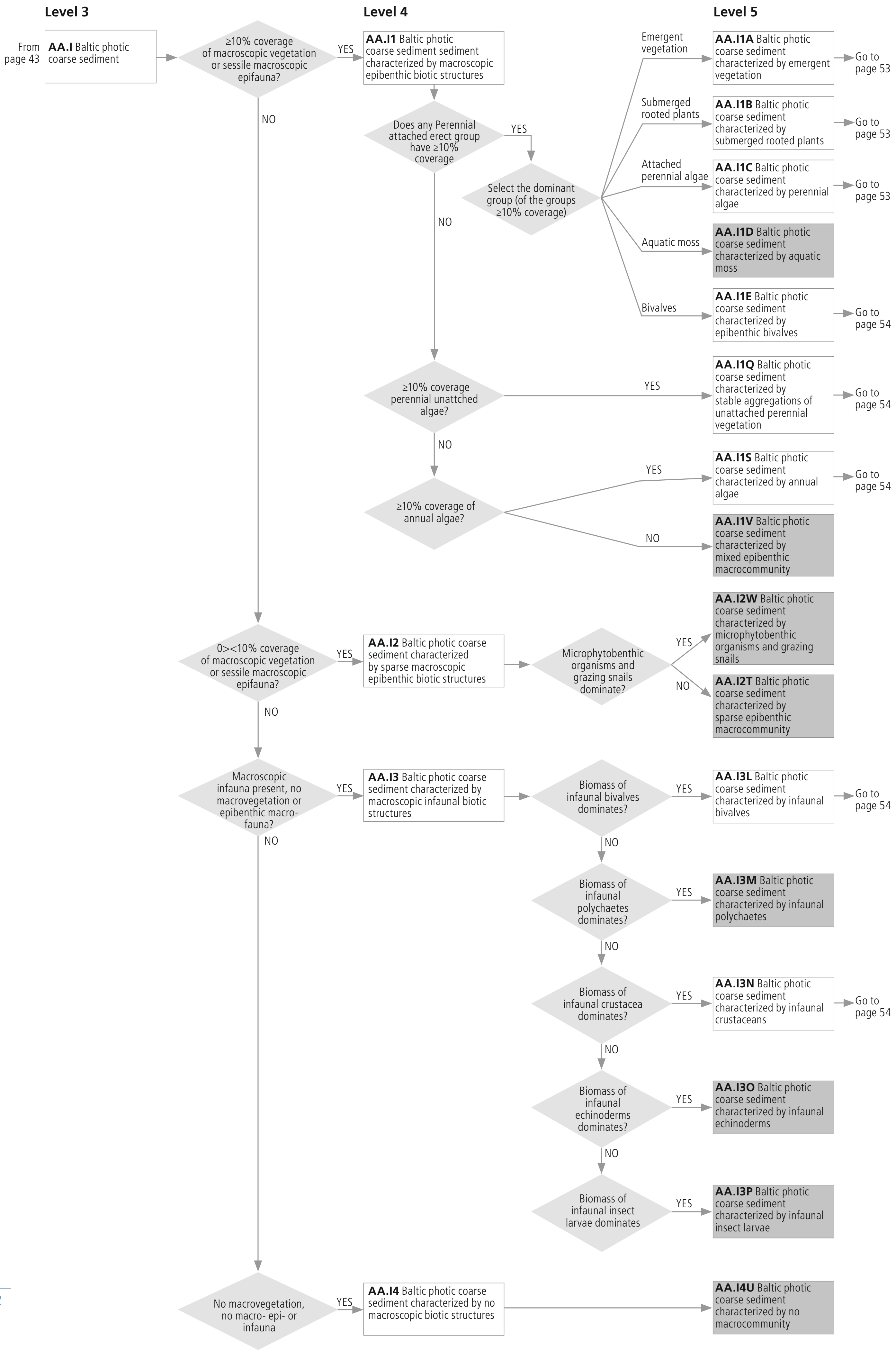
Level 5
Level 6
From page 48
AA.H1A Baltic photic muddy sediment characterized by emergent vegetation
≥50% biovolume common reed?
YES
AA.H1A1 Baltic photic muddy sediment dominated by common reed (Phragmites australis)
NO
≥50% biovolume sedges?
YES
AA.H1A2 Baltic photic muddy sediment dominated by sedges (Cyperaceae)
NO, stop at Level 5
From page 48
AA.H1B Baltic photic muddy sediment characterized by submerged rooted plants
≥50% biovolume pondweed?
YES
AA.H1B1 Baltic photic muddy sediment dominated by pondweed (Potamogeton perfoliatus and/or Stuckenia pectinata)
NO
≥50% biovolume Zannichellia ssp, Ruppia spp, Zostera noltii?
YES
AA.H1B2 Baltic photic muddy sediment dominated by Zannichellia spp. and/or Ruppia spp. and/or Zostera noltii
NO
≥50% biovolume watermilfoil?
YES
AA.H1B3 Baltic photic muddy sediment dominated by watermilfoil (Myriophyllum spicatum and/or Myriophyllum sibiricum)
NO
≥50% biovolume Charales?
YES
AA.H1B4 Baltic photic muddy sediment dominated by Charales
NO
≥50% biovolume spiny naiad?
YES
AA.H1B5 Baltic photic muddy sediment dominated by spiny naiad (Najas marina)
NO
≥50% biovolume Ranunculus spp?
YES
AA.H1B6 Baltic photic muddy sediment dominated by Ranunculus spp.
NO
≥50% biovolume common eelgrass?
YES
AA.H1B7 Baltic photic muddy sediment dominated by common eelgrass (Zostera marina)
NO
≥50% biovolume spikerush?
YES
AA.H1B8 Baltic photic muddy sediment dominated by spikerush (Eleocharis spp.)
NO, stop at Level 5

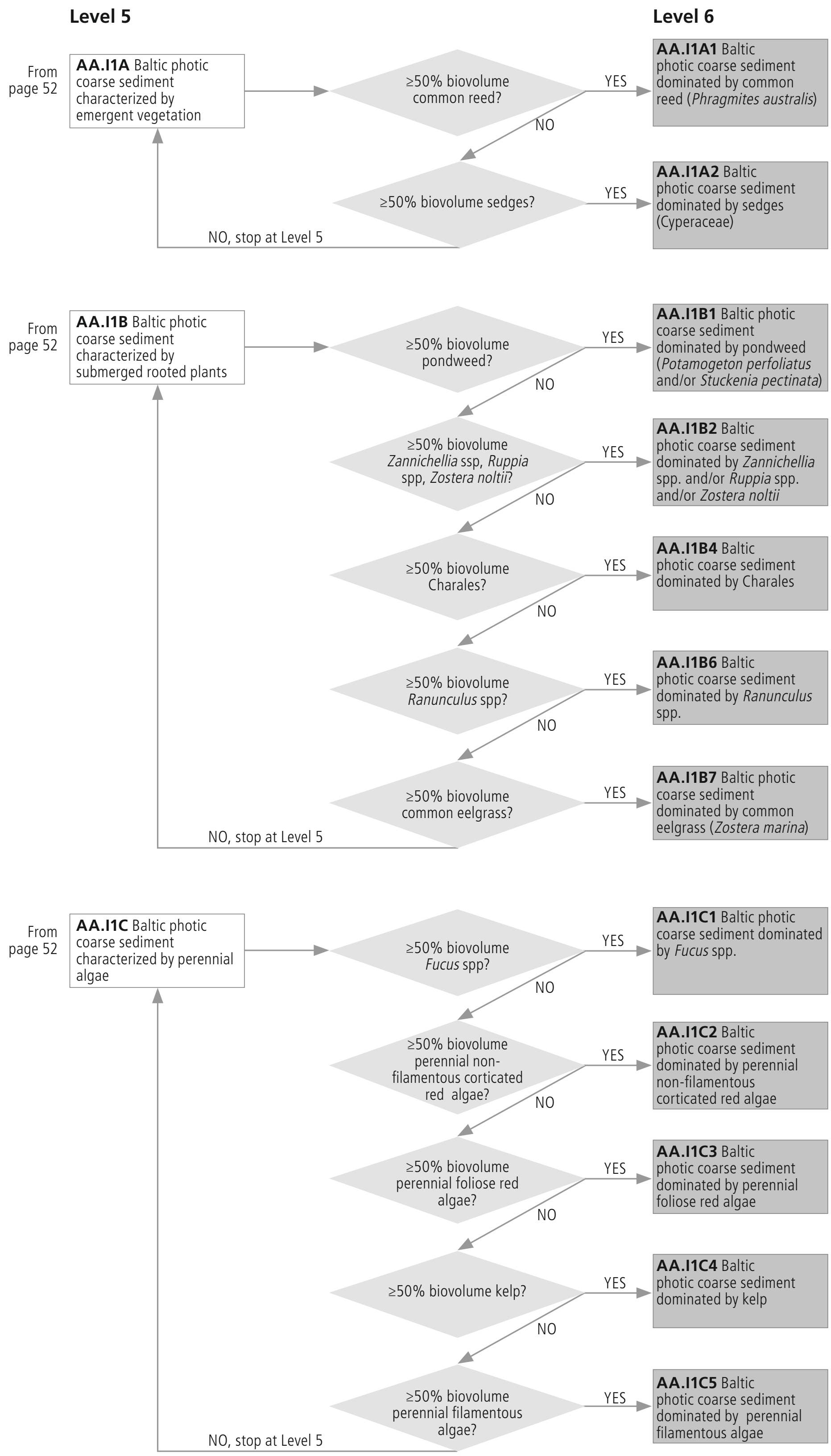


Level 5
Level 6
From page 48
AA.H1E Baltic photic muddy sediment characterized by epibenthic bivalves
≥50% biomass Mytilidae?
YES
AA.H1E1 Baltic photic muddy sediment dominated by Mytilidae
NO
≥50% biomass zebra mussel?
YES
AA.H1E2 Baltic photic muddy sediment dominated by zebra mussel (*Dreissena polymorpha*)
NO
≥50% biomass valve snail?
YES
AA.H1E3 Baltic photic muddy sediment dominated by valve snails (*Valvata* spp.)
NO, stop at Level 5
From page 48
AA.H1K Baltic photic muddy sediment characterized by epibenthic polychaetes
≥50% biomass tube building polychaetes (*Maldanidae* spp. and/or *Terebellida* spp.)?
YES
AA.H1K1 Baltic photic muddy sediment dominated by tube building polychaetes
NO, stop at Level 5
From page 48
AA.H1Q Baltic photic muddy sediment characterized by stable aggregations of unattached perennial vegetation
≥50% biovolume stable aggregations of unattached *Fucus* spp. (typical form)?
YES
AA.H1Q1 Baltic photic muddy sediment dominated by stable aggregations of unattached *Fucus* spp. (typical form)
NO
≥50 % biovolume stable aggregations of unattached *Fucus* spp. (dwarf form)?
YES
AA.H1Q2 Baltic photic muddy sediment dominated by stable aggregations of unattached *Fucus* spp. (dwarf form)
NO
≥50% biovolume *Furcellaria lumbricalis*?
YES
AA.H1Q3 Baltic photic muddy sediment dominated by stable aggregations of unattached *Furcellaria lumbricalis*
NO
≥50% biovolume rigid hornwort *Ceratophyllum demersum*?
YES
AA.H1Q4 Baltic photic muddy sediment dominated by stable aggregations of unattached rigid hornwort (*Ceratophyllum demersum*)
NO
≥50% biovolume lake ball?
YES
AA.H1Q5 Baltic photic muddy sediment dominated by stable unattached aggregations of lake ball (*Aegagropila linnaei*)
NO, stop at Level 5
From page 48
AA.H1S Baltic photic muddy sediment characterized by annual algae
≥50 % biovolume *Vaucheria* spp.?
YES
AA.H1S3 Baltic photic muddy sediment dominated by *Vaucheria* spp.
NO, stop at Level 5

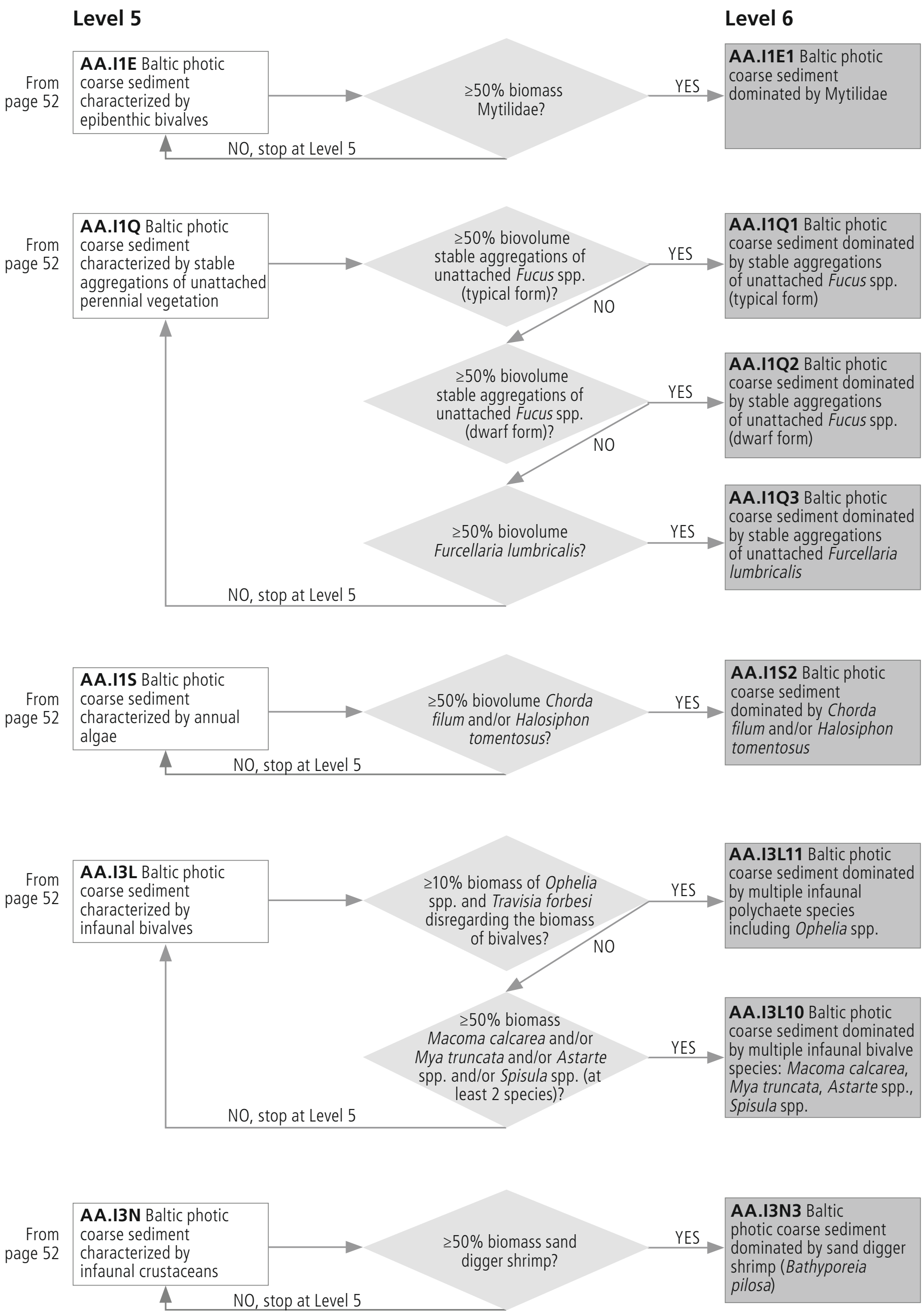


Level 5
Level 6
From page 48
AA.H3L Baltic photic muddy sediment characterized by infaunal bivalves
≥50% biomass baltic tellin?
YES
AA.H3L1 Baltic photic muddy sediment dominated by Baltic tellin (Macoma balthica)
NO
≥50% biomass ocean quahog?
YES
AA.H3L3 Baltic photic muddy sediment dominated by ocean quahog (Arctica islandica)
NO
≥50% biomass Unionidae?
YES
AA.H3L6 Baltic photic muddy sediment dominated by Unionidae
NO
≥50% biomass Abra spp.?
YES
AA.H3L8 Baltic photic muddy sediment dominated by Abra spp.
NO, stop at Level 5
From page 48
AA.H3M Baltic photic muddy sediment characterized by infaunal polychaetes
≥50% biomass Marenzelleria spp.?
YES
AA.H3M3 Baltic photic muddy sediment dominated by Marenzelleria spp.
NO
≥50% biomass Polydora ciliata and/or Lagis koreni and/or Capitella capitata and/or Scoloplos (Scoloplos) armiger?
YES
AA.H3M5 Baltic photic muddy sediment dominated by various opportunistic polychaetes
NO, stop at Level 5
From page 48
AA.H3N Baltic photic muddy sediment characterized by infaunal crustaceans
≥50% biomass Monoporeia affinis?
YES
AA.H3N1 Baltic photic muddy sediment dominated by Monoporeia affinis
NO
≥50% biomass mud shrimp?
YES
AA.H3N2 Baltic photic muddy sediment dominated by mud shrimps (Corophiidae)
NO, stop at Level 5
From page 48
AA.H3P Baltic photic muddy sediment characterized by infaunal insect larvae
≥50% biomass midge larvae?
YES
AA.H3P1 Baltic photic muddy sediment dominated by midge larvae (Chironomidae)
NO, stop at Level 5
From page 48
AA.H4U Baltic photic muddy sediment characterized by no macrocommunity
≥50% biomass meiofauna?
YES
AA.H4U1 Baltic photic muddy sediment dominated by meiofauna (Oligochaeta, Ostracoda, Nematoda)
NO, stop at Level 5

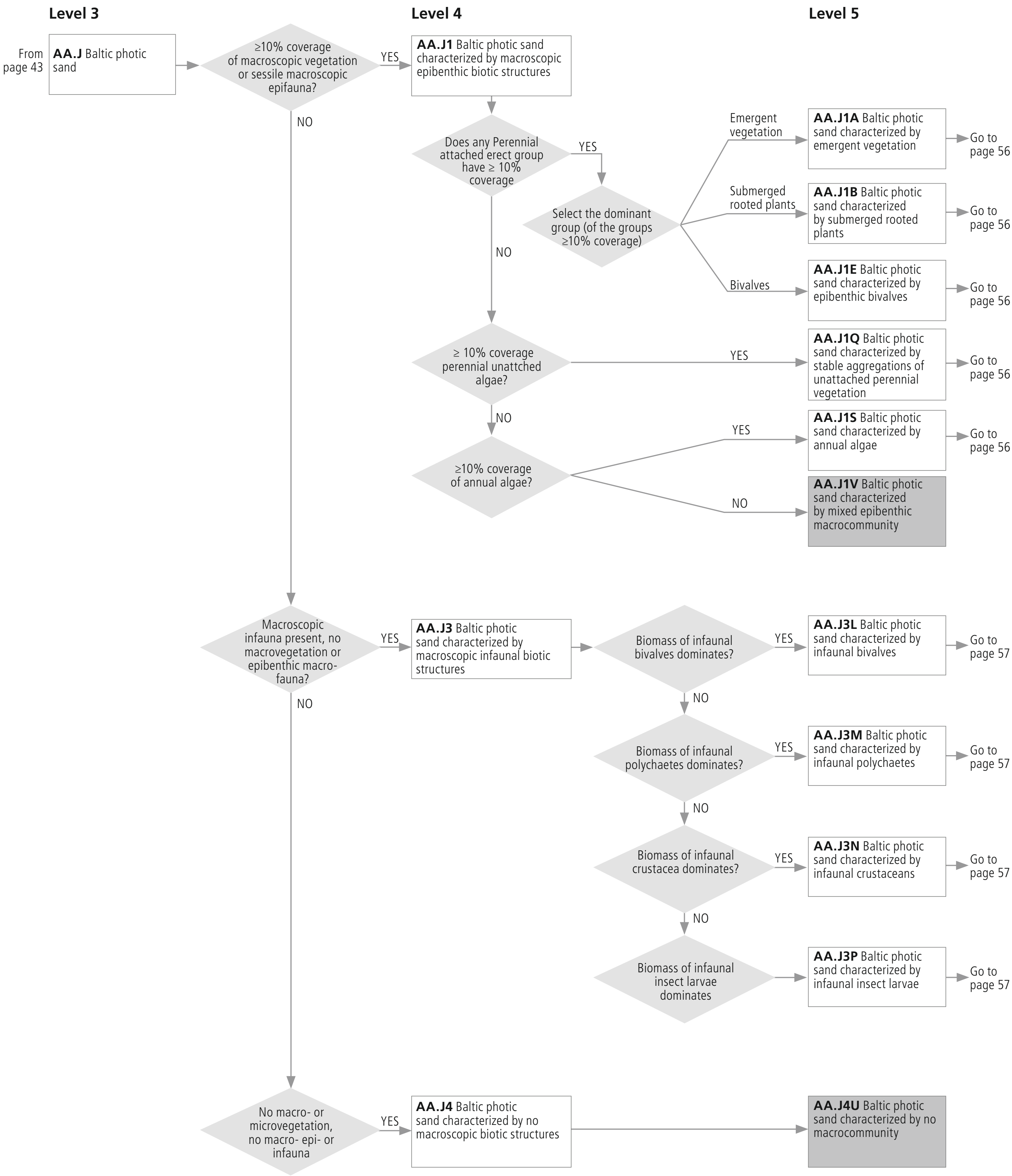

Level 3
Level 4
Level 5
From page 43
AA.I Baltic photic coarse sediment
≥10% coverage of macroscopic vegetation or sessile macroscopic epifauna?
YES
NO
AA.I1 Baltic photic coarse sediment sediment characterized by macroscopic epibenthic biotic structures
Does any Perennial attached erect group have ≥10% coverage
YES
NO
Select the dominant group (of the groups ≥10% coverage)
Emergent vegetation
AA.I1A Baltic photic coarse sediment characterized by emergent vegetation
Go to page 53
Submerged rooted plants
AA.I1B Baltic photic coarse sediment characterized by submerged rooted plants
Go to page 53
Attached perennial algae
AA.I1C Baltic photic coarse sediment characterized by perennial algae
Go to page 53
Aquatic moss
AA.I1D Baltic photic coarse sediment characterized by aquatic moss
Bivalves
AA.I1E Baltic photic coarse sediment characterized by epibenthic bivalves
Go to page 54
≥10% coverage perennial unattched algae?
YES
AA.I1Q Baltic photic coarse sediment characterized by stable aggregations of unattached perennial vegetation
Go to page 54
NO
≥10% coverage of annual algae?
YES
AA.I1S Baltic photic coarse sediment characterized by annual algae
Go to page 54
NO
AA.I1V Baltic photic coarse sediment characterized by mixed epibenthic macrocommunity
0><10% coverage of macroscopic vegetation or sessile macroscopic epifauna?
YES
AA.I2 Baltic photic coarse sediment characterized by sparse macroscopic epibenthic biotic structures
Microphytobenthic organisms and grazing snails dominate?
YES
AA.I2W Baltic photic coarse sediment characterized by microphytobenthic organisms and grazing snails
NO
AA.I2T Baltic photic coarse sediment characterized by sparse epibenthic macrocommunity
NO
Macroscopic infauna present, no macrovegetation or epibenthic macro-fauna?
YES
AA.I3 Baltic photic coarse sediment characterized by macroscopic infaunal biotic structures
Biomass of infaunal bivalves dominates?
YES
AA.I3L Baltic photic coarse sediment characterized by infaunal bivalves
Go to page 54
NO
Biomass of infaunal polychaetes dominates?
YES
AA.I3M Baltic photic coarse sediment characterized by infaunal polychaetes
NO
Biomass of infaunal crustacea dominates?
YES
AA.I3N Baltic photic coarse sediment characterized by infaunal crustaceans
Go to page 54
NO
Biomass of infaunal echinoderms dominates?
YES
AA.I3O Baltic photic coarse sediment characterized by infaunal echinoderms
NO
Biomass of infaunal insect larvae dominates
YES
AA.I3P Baltic photic coarse sediment characterized by infaunal insect larvae
NO
No macrovegetation, no macro- epi- or infauna
YES
AA.I4 Baltic photic coarse sediment characterized by no macroscopic biotic structures
AA.I4U Baltic photic coarse sediment characterized by no macrocommunity

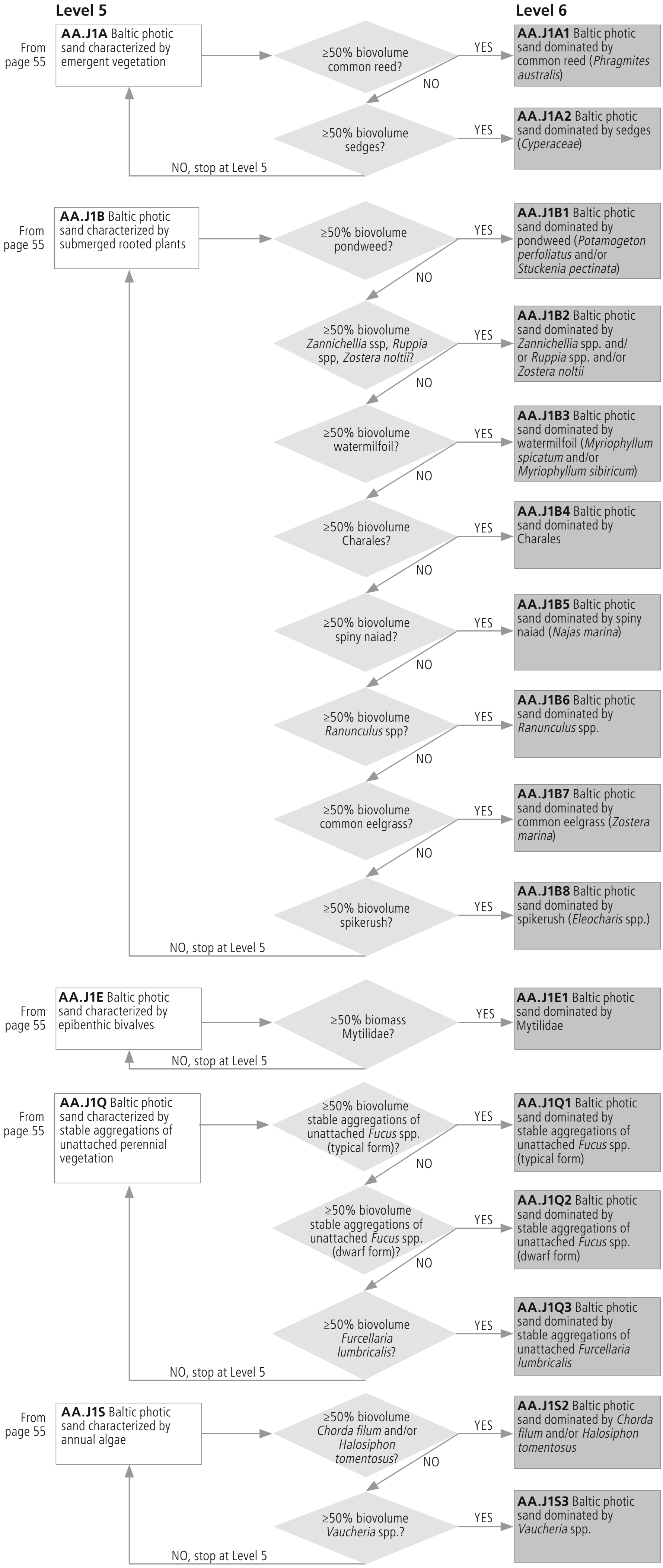


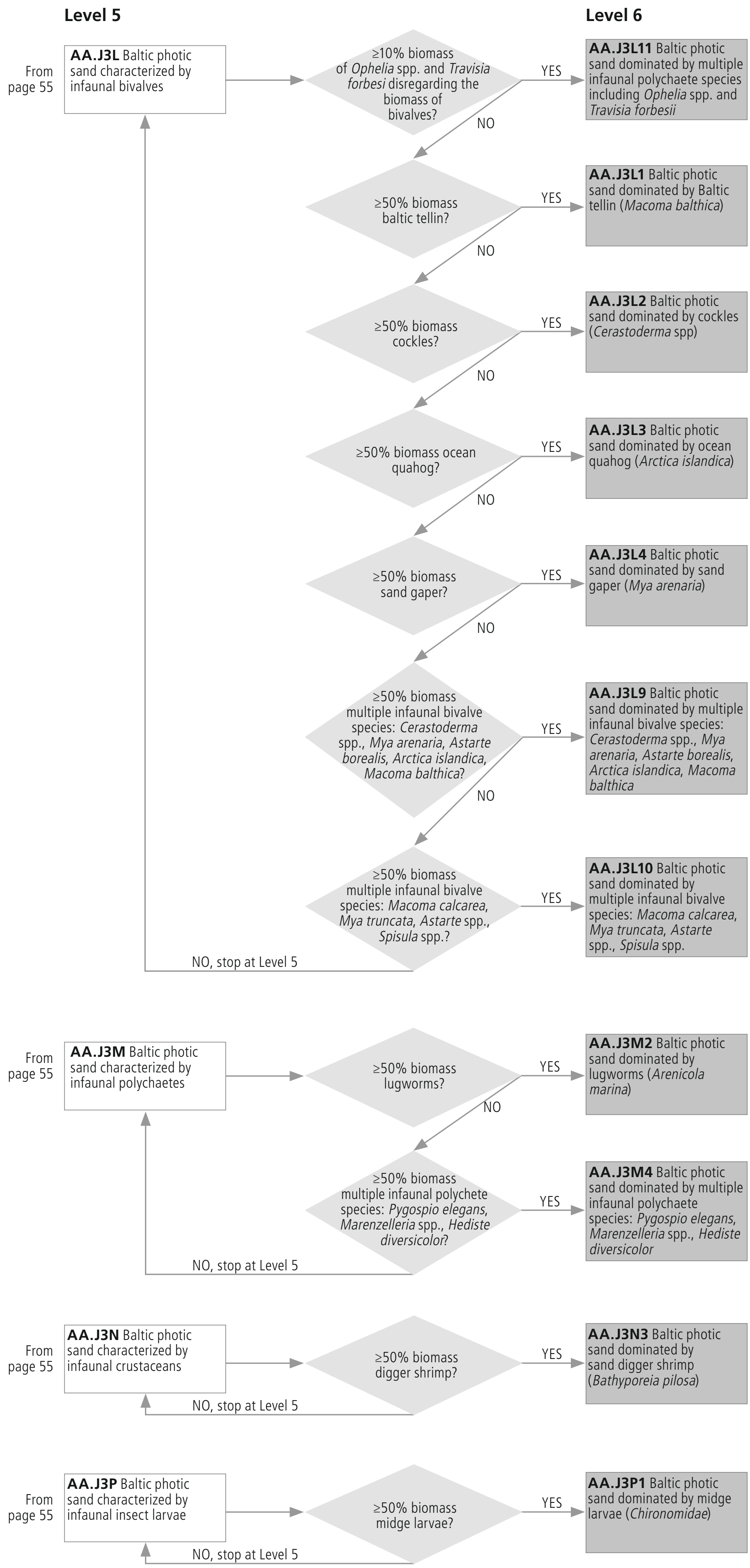
Level 5
Level 6
From page 52
AA.I1A Baltic photic coarse sediment characterized by emergent vegetation
≥50% biovolume common reed?
YES
NO
AA.I1A1 Baltic photic coarse sediment dominated by common reed (Phragmites australis)
≥50% biovolume sedges?
YES
AA.I1A2 Baltic photic coarse sediment dominated by sedges (Cyperaceae)
NO, stop at Level 5
From page 52
AA.I1B Baltic photic coarse sediment characterized by submerged rooted plants
≥50% biovolume pondweed?
YES
NO
AA.I1B1 Baltic photic coarse sediment dominated by pondweed (Potamogeton perfoliatus and/or Stuckenia pectinata)
≥50% biovolume Zannichellia ssp, Ruppia spp, Zostera noltii?
YES
NO
AA.I1B2 Baltic photic coarse sediment dominated by Zannichellia spp. and/or Ruppia spp. and/or Zostera noltii
≥50% biovolume Charales?
YES
NO
AA.I1B4 Baltic photic coarse sediment dominated by Charales
≥50% biovolume Ranunculus spp?
YES
NO
AA.I1B6 Baltic photic coarse sediment dominated by Ranunculus spp.
≥50% biovolume common eelgrass?
YES
AA.I1B7 Baltic photic coarse sediment dominated by common eelgrass (Zostera marina)
NO, stop at Level 5
From page 52
AA.I1C Baltic photic coarse sediment characterized by perennial algae
≥50% biovolume Fucus spp?
YES
NO
AA.I1C1 Baltic photic coarse sediment dominated by Fucus spp.
≥50% biovolume perennial non-filamentous corticated red algae?
YES
NO
AA.I1C2 Baltic photic coarse sediment dominated by perennial non-filamentous corticated red algae
≥50% biovolume perennial foliose red algae?
YES
NO
AA.I1C3 Baltic photic coarse sediment dominated by perennial foliose red algae
≥50% biovolume kelp?
YES
NO
AA.I1C4 Baltic photic coarse sediment dominated by kelp
≥50% biovolume perennial filamentous algae?
YES
AA.I1C5 Baltic photic coarse sediment dominated by perennial filamentous algae
NO, stop at Level 5

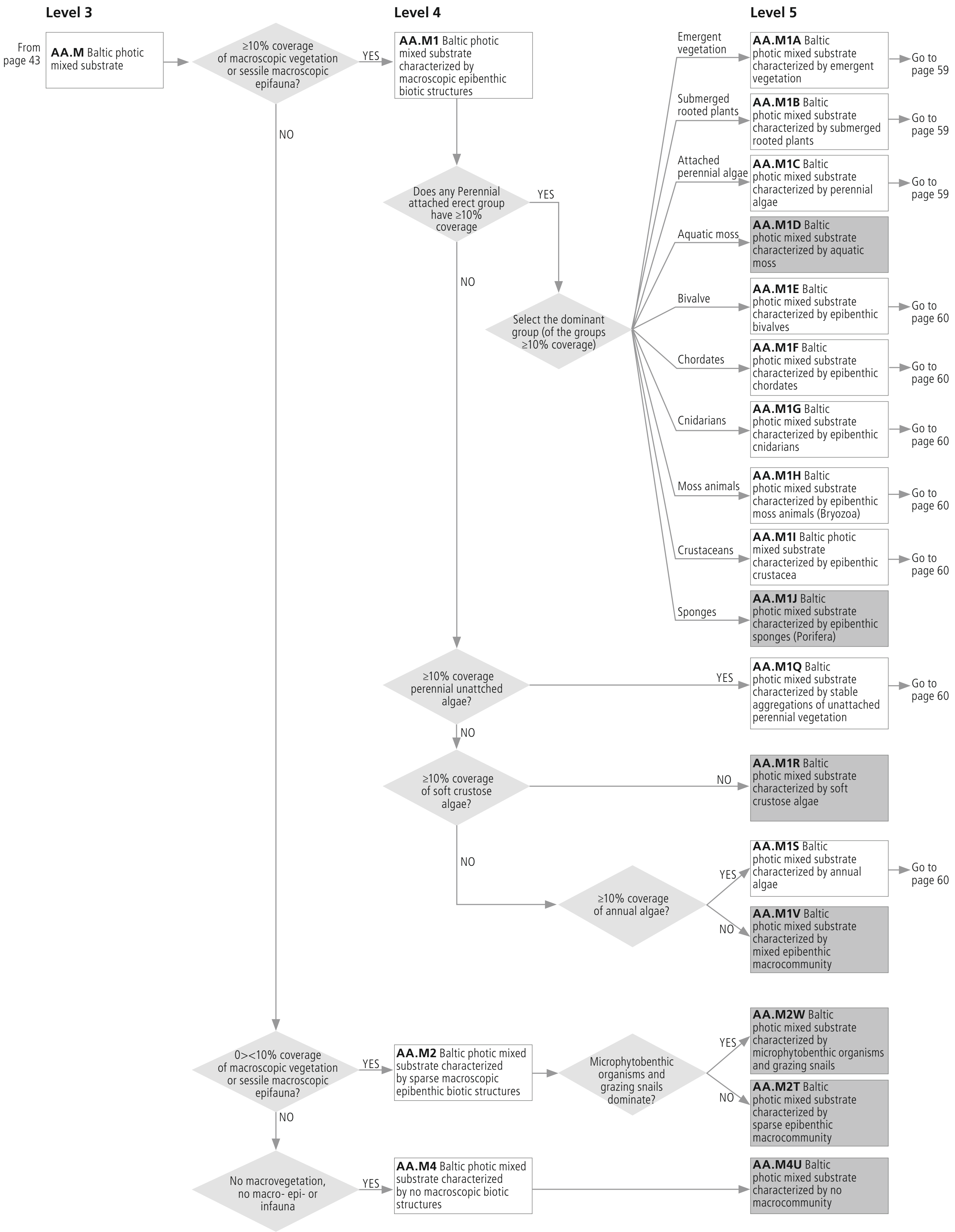


Level 5
Level 6
From page 52
AA.I1E Baltic photic coarse sediment characterized by epibenthic bivalves
≥50% biomass Mytilidae?
YES
AA.I1E1 Baltic photic coarse sediment dominated by Mytilidae
NO, stop at Level 5
From page 52
AA.I1Q Baltic photic coarse sediment characterized by stable aggregations of unattached perennial vegetation
≥50% biovolume stable aggregations of unattached Fucus spp. (typical form)?
YES
AA.I1Q1 Baltic photic coarse sediment dominated by stable aggregations of unattached Fucus spp. (typical form)
NO
≥50% biovolume stable aggregations of unattached Fucus spp. (dwarf form)?
YES
AA.I1Q2 Baltic photic coarse sediment dominated by stable aggregations of unattached Fucus spp. (dwarf form)
NO
≥50% biovolume Furcellaria lumbricalis?
YES
AA.I1Q3 Baltic photic coarse sediment dominated by stable aggregations of unattached Furcellaria lumbricalis
NO, stop at Level 5
From page 52
AA.I1S Baltic photic coarse sediment characterized by annual algae
≥50% biovolume Chorda filum and/or Halosiphon tomentosus?
YES
AA.I1S2 Baltic photic coarse sediment dominated by Chorda filum and/or Halosiphon tomentosus
NO, stop at Level 5
From page 52
AA.I3L Baltic photic coarse sediment characterized by infaunal bivalves
≥10% biomass of Ophelia spp. and Travisia forbesi disregarding the biomass of bivalves?
YES
AA.I3L11 Baltic photic coarse sediment dominated by multiple infaunal polychaete species including Ophelia spp.
NO
≥50% biomass Macoma calcarea and/or Mya truncata and/or Astarte spp. and/or Spisula spp. (at least 2 species)?
YES
AA.I3L10 Baltic photic coarse sediment dominated by multiple infaunal bivalve species: Macoma calcarea, Mya truncata, Astarte spp., Spisula spp.
NO, stop at Level 5
From page 52
AA.I3N Baltic photic coarse sediment characterized by infaunal crustaceans
≥50% biomass sand digger shrimp?
YES
AA.I3N3 Baltic photic coarse sediment dominated by sand digger shrimp (Bathyporeia pilosa)
NO, stop at Level 5

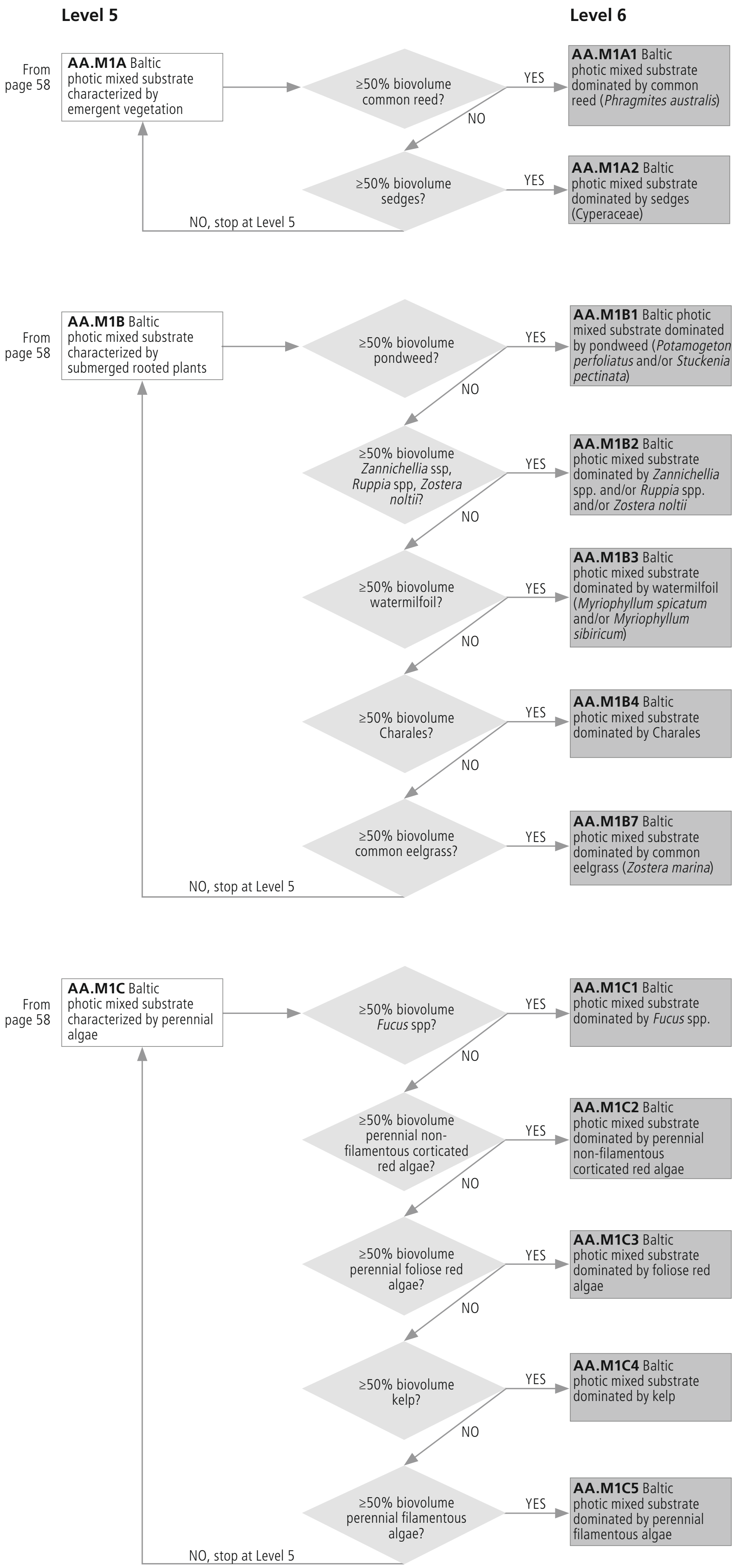

Level 3
Level 4
Level 5
From page 43
AA.J Baltic photic sand
≥10% coverage of macroscopic vegetation or sessile macroscopic epifauna?
YES
NO
AA.J1 Baltic photic sand characterized by macroscopic epibenthic biotic structures
Does any Perennial attached erect group have ≥ 10% coverage
YES
NO
Select the dominant group (of the groups ≥10% coverage)
Emergent vegetation
AA.J1A Baltic photic sand characterized by emergent vegetation
Go to page 56
Submerged rooted plants
AA.J1B Baltic photic sand characterized by submerged rooted plants
Go to page 56
Bivalves
AA.J1E Baltic photic sand characterized by epibenthic bivalves
Go to page 56
≥ 10% coverage perennial unattched algae?
YES
NO
AA.J1Q Baltic photic sand characterized by stable aggregations of unattached perennial vegetation
Go to page 56
≥10% coverage of annual algae?
YES
AA.J1S Baltic photic sand characterized by annual algae
Go to page 56
NO
AA.J1V Baltic photic sand characterized by mixed epibenthic macrocommunity
Macroscopic infauna present, no macrovegetation or epibenthic macro-fauna?
YES
NO
AA.J3 Baltic photic sand characterized by macroscopic infaunal biotic structures
Biomass of infaunal bivalves dominates?
YES
AA.J3L Baltic photic sand characterized by infaunal bivalves
Go to page 57
NO
Biomass of infaunal polychaetes dominates?
YES
AA.J3M Baltic photic sand characterized by infaunal polychaetes
Go to page 57
NO
Biomass of infaunal crustacea dominates?
YES
AA.J3N Baltic photic sand characterized by infaunal crustaceans
Go to page 57
NO
Biomass of infaunal insect larvae dominates
AA.J3P Baltic photic sand characterized by infaunal insect larvae
Go to page 57
No macro- or microvegetation, no macro- epi- or infauna
YES
AA.J4 Baltic photic sand characterized by no macroscopic biotic structures
AA.J4U Baltic photic sand characterized by no macrocommunity

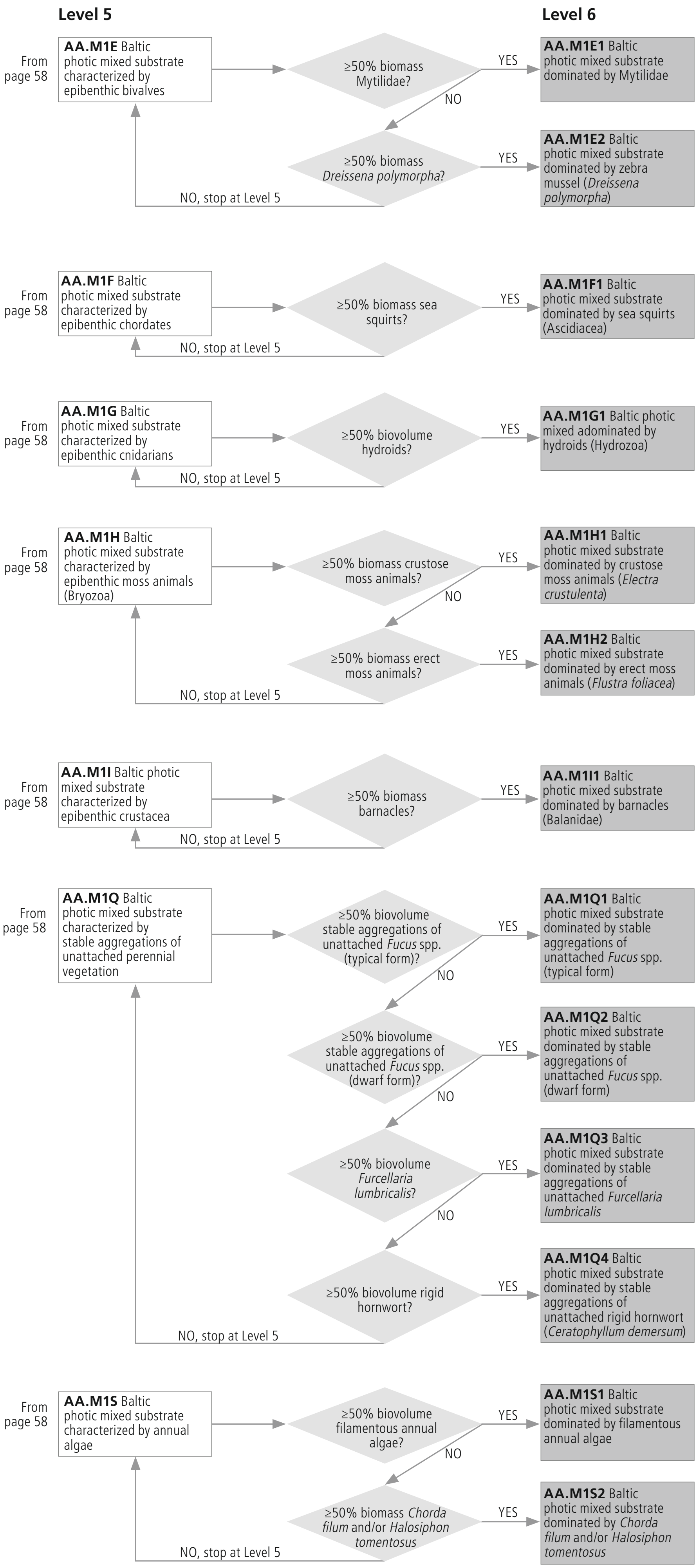

Level 5
Level 6
From page 55
AA.J1A Baltic photic sand characterized by emergent vegetation
≥50% biovolume common reed?
YES
NO
AA.J1A1 Baltic photic sand dominated by common reed (Phragmites australis)
≥50% biovolume sedges?
YES
AA.J1A2 Baltic photic sand dominated by sedges (Cyperaceae)
NO, stop at Level 5
From page 55
AA.J1B Baltic photic sand characterized by submerged rooted plants
≥50% biovolume pondweed?
YES
NO
AA.J1B1 Baltic photic sand dominated by pondweed (Potamogeton perfoliatus and/or Stuckenia pectinata)
≥50% biovolume Zannichellia ssp, Ruppia spp, Zostera noltii?
YES
NO
AA.J1B2 Baltic photic sand dominated by Zannichellia spp. and/or Ruppia spp. and/or Zostera noltii
≥50% biovolume watermilfoil?
YES
NO
AA.J1B3 Baltic photic sand dominated by watermilfoil (Myriophyllum spicatum and/or Myriophyllum sibiricum)
≥50% biovolume Charales?
YES
NO
AA.J1B4 Baltic photic sand dominated by Charales
≥50% biovolume spiny naiad?
YES
NO
AA.J1B5 Baltic photic sand dominated by spiny naiad (Najas marina)
≥50% biovolume Ranunculus spp?
YES
NO
AA.J1B6 Baltic photic sand dominated by Ranunculus spp.
≥50% biovolume common eelgrass?
YES
NO
AA.J1B7 Baltic photic sand dominated by common eelgrass (Zostera marina)
≥50% biovolume spikerush?
YES
AA.J1B8 Baltic photic sand dominated by spikerush (Eleocharis spp.)
NO, stop at Level 5
From page 55
AA.J1E Baltic photic sand characterized by epibenthic bivalves
≥50% biomass Mytilidae?
YES
AA.J1E1 Baltic photic sand dominated by Mytilidae
NO, stop at Level 5
From page 55
AA.J1Q Baltic photic sand characterized by stable aggregations of unattached perennial vegetation
≥50% biovolume stable aggregations of unattached Fucus spp. (typical form)?
YES
NO
AA.J1Q1 Baltic photic sand dominated by stable aggregations of unattached Fucus spp. (typical form)
≥50% biovolume stable aggregations of unattached Fucus spp. (dwarf form)?
YES
NO
AA.J1Q2 Baltic photic sand dominated by stable aggregations of unattached Fucus spp. (dwarf form)
≥50% biovolume Furcellaria lumbricalis?
YES
AA.J1Q3 Baltic photic sand dominated by stable aggregations of unattached Furcellaria lumbricalis
NO, stop at Level 5
From page 55
AA.J1S Baltic photic sand characterized by annual algae
≥50% biovolume Chorda filum and/or Halosiphon tomentosus?
YES
NO
AA.J1S2 Baltic photic sand dominated by Chorda filum and/or Halosiphon tomentosus
≥50% biovolume Vaucheria spp.?
YES
AA.J1S3 Baltic photic sand dominated by Vaucheria spp.
NO, stop at Level 5

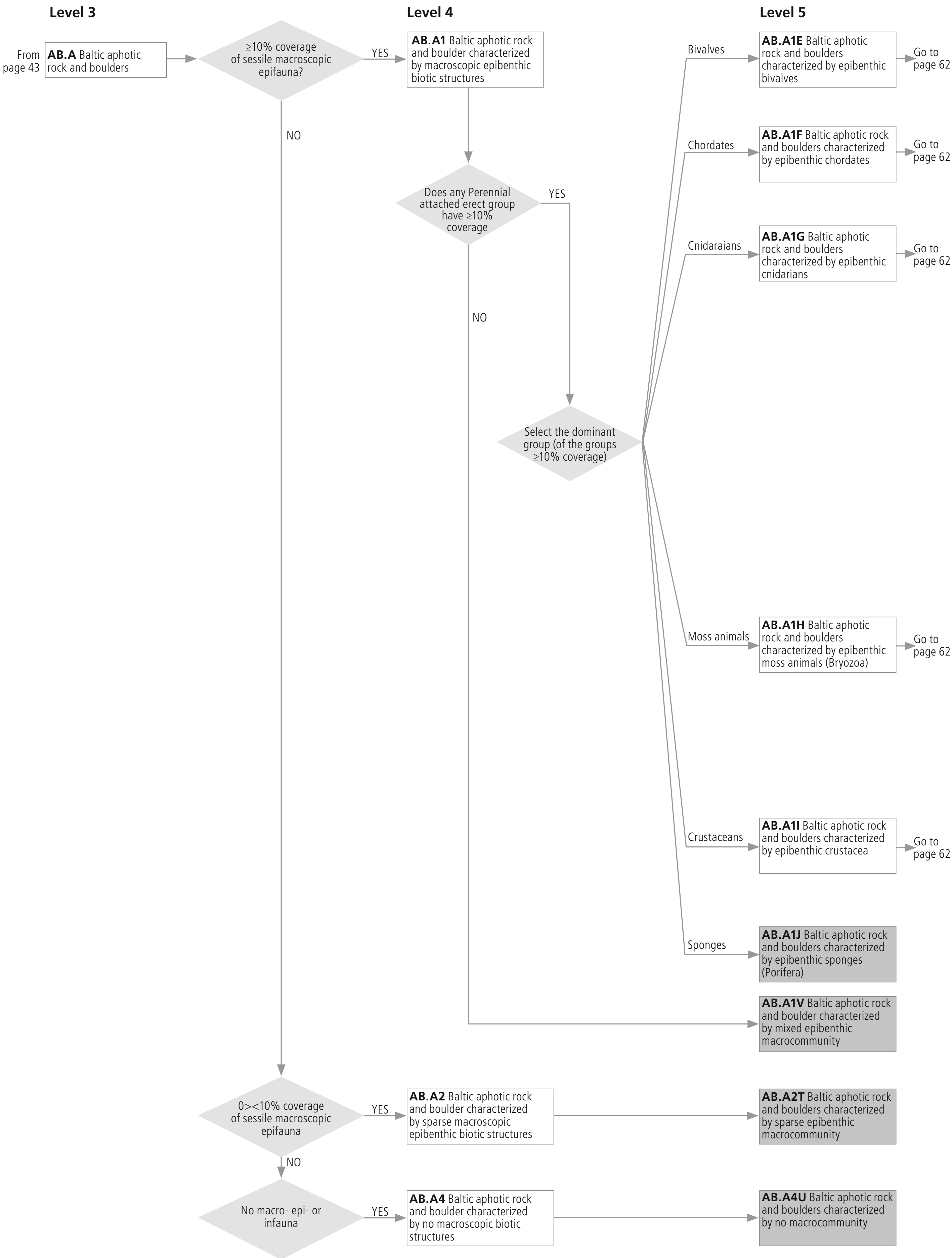

Level 5
Level 6
From page 55
AA.J3L Baltic photic sand characterized by infaunal bivalves
≥10% biomass of Ophelia spp. and Travisia forbesi disregarding the biomass of bivalves?
YES
AA.J3L11 Baltic photic sand dominated by multiple infaunal polychaete species including Ophelia spp. and Travisia forbesii
NO
≥50% biomass baltic tellin?
YES
AA.J3L1 Baltic photic sand dominated by Baltic tellin (Macoma balthica)
NO
≥50% biomass cockles?
YES
AA.J3L2 Baltic photic sand dominated by cockles (Cerastoderma spp)
NO
≥50% biomass ocean quahog?
YES
AA.J3L3 Baltic photic sand dominated by ocean quahog (Arctica islandica)
NO
≥50% biomass sand gaper?
YES
AA.J3L4 Baltic photic sand dominated by sand gaper (Mya arenaria)
NO
≥50% biomass multiple infaunal bivalve species: Cerastoderma spp., Mya arenaria, Astarte borealis, Arctica islandica, Macoma balthica?
YES
AA.J3L9 Baltic photic sand dominated by multiple infaunal bivalve species: Cerastoderma spp., Mya arenaria, Astarte borealis, Arctica islandica, Macoma balthica
NO
≥50% biomass multiple infaunal bivalve species: Macoma calcarea, Mya truncata, Astarte spp., Spisula spp.?
YES
AA.J3L10 Baltic photic sand dominated by multiple infaunal bivalve species: Macoma calcarea, Mya truncata, Astarte spp., Spisula spp.
NO, stop at Level 5
From page 55
AA.J3M Baltic photic sand characterized by infaunal polychaetes
≥50% biomass lugworms?
YES
AA.J3M2 Baltic photic sand dominated by lugworms (Arenicola marina)
NO
≥50% biomass multiple infaunal polychete species: Pygospio elegans, Marenzelleria spp., Hediste diversicolor?
YES
AA.J3M4 Baltic photic sand dominated by multiple infaunal polychaete species: Pygospio elegans, Marenzelleria spp., Hediste diversicolor
NO, stop at Level 5
From page 55
AA.J3N Baltic photic sand characterized by infaunal crustaceans
≥50% biomass digger shrimp?
YES
AA.J3N3 Baltic photic sand dominated by sand digger shrimp (Bathyporeia pilosa)
NO, stop at Level 5
From page 55
AA.J3P Baltic photic sand characterized by infaunal insect larvae
≥50% biomass midge larvae?
YES
AA.J3P1 Baltic photic sand dominated by midge larvae (Chironomidae)
NO, stop at Level 5



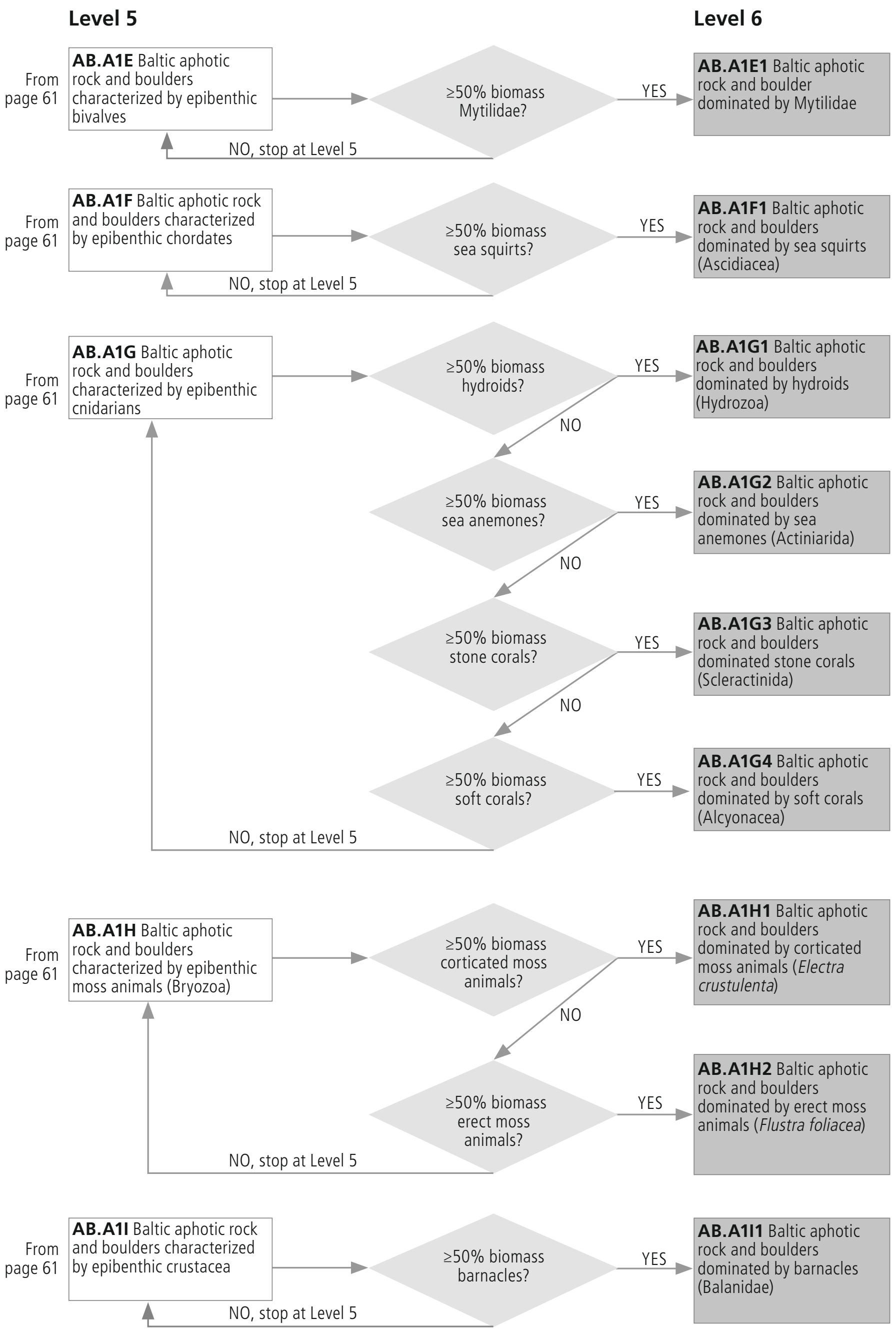
Level 3
Level 4
Level 5
From page 43
AA.M Baltic photic mixed substrate
≥10% coverage of macroscopic vegetation or sessile macroscopic epifauna?
YES
NO
AA.M1 Baltic photic mixed substrate characterized by macroscopic epibenthic biotic structures
Does any Perennial attached erect group have ≥10% coverage
YES
NO
Select the dominant group (of the groups ≥10% coverage)
Emergent vegetation
AA.M1A Baltic photic mixed substrate characterized by emergent vegetation
Go to page 59
Submerged rooted plants
AA.M1B Baltic photic mixed substrate characterized by submerged rooted plants
Go to page 59
Attached perennial algae
AA.M1C Baltic photic mixed substrate characterized by perennial algae
Go to page 59
Aquatic moss
AA.M1D Baltic photic mixed substrate characterized by aquatic moss
Bivalve
AA.M1E Baltic photic mixed substrate characterized by epibenthic bivalves
Go to page 60
Chordates
AA.M1F Baltic photic mixed substrate characterized by epibenthic chordates
Go to page 60
Cnidarians
AA.M1G Baltic photic mixed substrate characterized by epibenthic cnidarians
Go to page 60
Moss animals
AA.M1H Baltic photic mixed substrate characterized by epibenthic moss animals (Bryozoa)
Go to page 60
Crustaceans
AA.M1I Baltic photic mixed substrate characterized by epibenthic crustacea
Go to page 60
Sponges
AA.M1J Baltic photic mixed substrate characterized by epibenthic sponges (Porifera)
≥10% coverage perennial unattched algae?
YES
AA.M1Q Baltic photic mixed substrate characterized by stable aggregations of unattached perennial vegetation
Go to page 60
NO
≥10% coverage of soft crustose algae?
NO
AA.M1R Baltic photic mixed substrate characterized by soft crustose algae
NO
≥10% coverage of annual algae?
YES
AA.M1S Baltic photic mixed substrate characterized by annual algae
Go to page 60
NO
AA.M1V Baltic photic mixed substrate characterized by mixed epibenthic macrocommunity
0><10% coverage of macroscopic vegetation or sessile macroscopic epifauna?
YES
AA.M2 Baltic photic mixed substrate characterized by sparse macroscopic epibenthic biotic structures
Microphytobenthic organisms and grazing snails dominate?
YES
AA.M2W Baltic photic mixed substrate characterized by microphytobenthic organisms and grazing snails
NO
AA.M2T Baltic photic mixed substrate characterized by sparse epibenthic macrocommunity
NO
No macrovegetation, no macro- epi- or infauna
YES
AA.M4 Baltic photic mixed substrate characterized by no macroscopic biotic structures
AA.M4U Baltic photic mixed substrate characterized by no macrocommunity

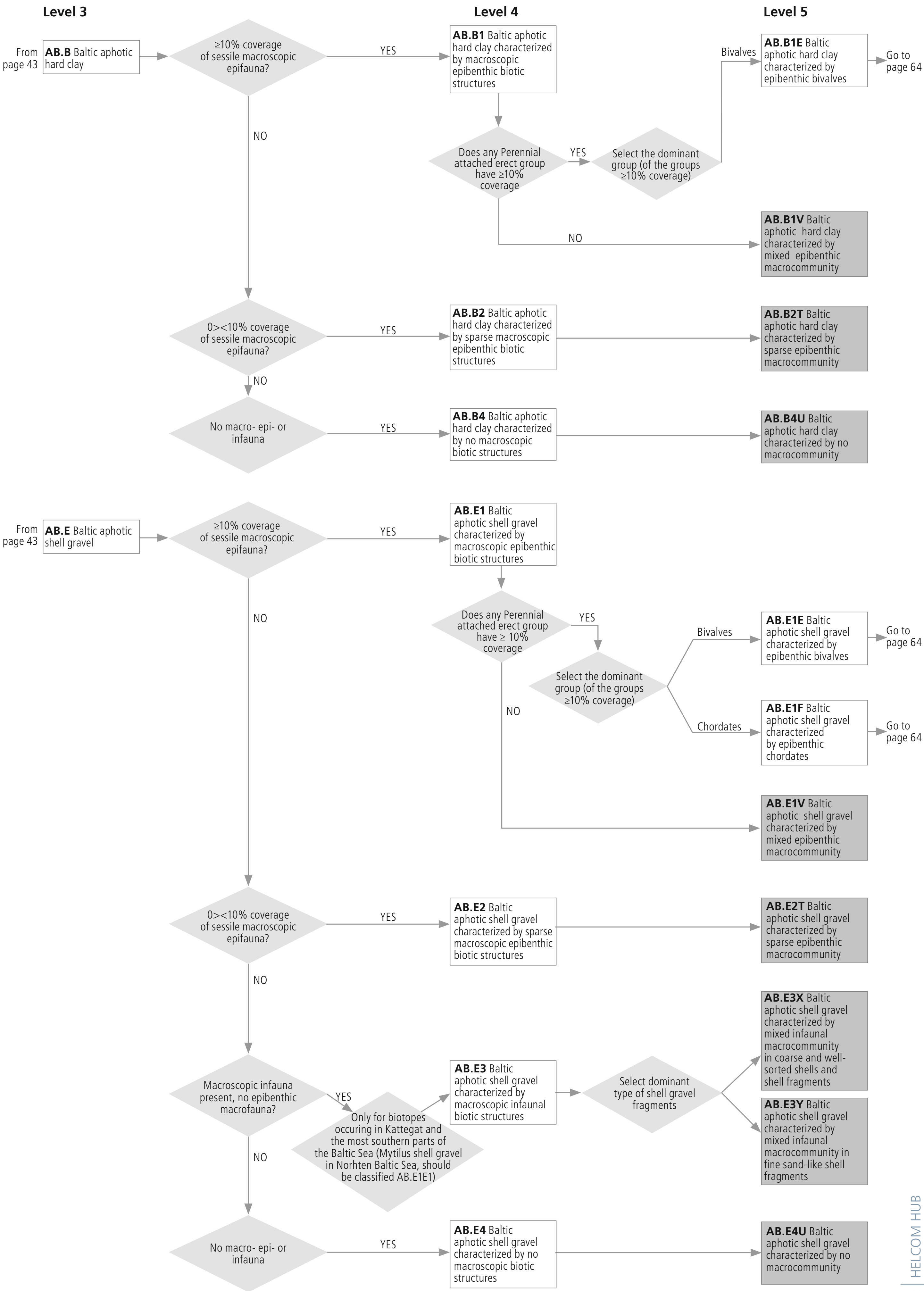

Level 5
Level 6
From page 58
AA.M1A Baltic photic mixed substrate characterized by emergent vegetation
≥50% biovolume common reed?
YES
AA.M1A1 Baltic photic mixed substrate dominated by common reed (Phragmites australis)
NO
≥50% biovolume sedges?
YES
AA.M1A2 Baltic photic mixed substrate dominated by sedges (Cyperaceae)
NO, stop at Level 5
From page 58
AA.M1B Baltic photic mixed substrate characterized by submerged rooted plants
≥50% biovolume pondweed?
YES
AA.M1B1 Baltic photic mixed substrate dominated by pondweed (Potamogeton perfoliatus and/or Stuckenia pectinata)
NO
≥50% biovolume Zannichellia ssp, Ruppia spp, Zostera noltii?
YES
AA.M1B2 Baltic photic mixed substrate dominated by Zannichellia spp. and/or Ruppia spp. and/or Zostera noltii
NO
≥50% biovolume watermilfoil?
YES
AA.M1B3 Baltic photic mixed substrate dominated by watermilfoil (Myriophyllum spicatum and/or Myriophyllum sibiricum)
NO
≥50% biovolume Charales?
YES
AA.M1B4 Baltic photic mixed substrate dominated by Charales
NO
≥50% biovolume common eelgrass?
YES
AA.M1B7 Baltic photic mixed substrate dominated by common eelgrass (Zostera marina)
NO, stop at Level 5
From page 58
AA.M1C Baltic photic mixed substrate characterized by perennial algae
≥50% biovolume Fucus spp?
YES
AA.M1C1 Baltic photic mixed substrate dominated by Fucus spp.
NO
≥50% biovolume perennial non-filamentous corticated red algae?
YES
AA.M1C2 Baltic photic mixed substrate dominated by perennial non-filamentous corticated red algae
NO
≥50% biovolume perennial foliose red algae?
YES
AA.M1C3 Baltic photic mixed substrate dominated by foliose red algae
NO
≥50% biovolume kelp?
YES
AA.M1C4 Baltic photic mixed substrate dominated by kelp
NO
≥50% biovolume perennial filamentous algae?
YES
AA.M1C5 Baltic photic mixed substrate dominated by perennial filamentous algae
NO, stop at Level 5


Level 5
Level 6
From page 58
AA.M1E Baltic photic mixed substrate characterized by epibenthic bivalves
≥50% biomass Mytilidae?
YES
AA.M1E1 Baltic photic mixed substrate dominated by Mytilidae
NO
≥50% biomass Dreissena polymorpha?
YES
AA.M1E2 Baltic photic mixed substrate dominated by zebra mussel (Dreissena polymorpha)
NO, stop at Level 5
From page 58
AA.M1F Baltic photic mixed substrate characterized by epibenthic chordates
≥50% biomass sea squirts?
YES
AA.M1F1 Baltic photic mixed substrate dominated by sea squirts (Ascidiacea)
NO, stop at Level 5
From page 58
AA.M1G Baltic photic mixed substrate characterized by epibenthic cnidarians
≥50% biovolume hydroids?
YES
AA.M1G1 Baltic photic mixed adominated by hydroids (Hydrozoa)
NO, stop at Level 5
From page 58
AA.M1H Baltic photic mixed substrate characterized by epibenthic moss animals (Bryozoa)
≥50% biomass crustose moss animals?
YES
AA.M1H1 Baltic photic mixed substrate dominated by crustose moss animals (Electra crustulenta)
NO
≥50% biomass erect moss animals?
YES
AA.M1H2 Baltic photic mixed substrate dominated by erect moss animals (Flustra foliacea)
NO, stop at Level 5
From page 58
AA.M1I Baltic photic mixed substrate characterized by epibenthic crustacea
≥50% biomass barnacles?
YES
AA.M1I1 Baltic photic mixed substrate dominated by barnacles (Balanidae)
NO, stop at Level 5
From page 58
AA.M1Q Baltic photic mixed substrate characterized by stable aggregations of unattached perennial vegetation
≥50% biovolume stable aggregations of unattached Fucus spp. (typical form)?
YES
AA.M1Q1 Baltic photic mixed substrate dominated by stable aggregations of unattached Fucus spp. (typical form)
NO
≥50% biovolume stable aggregations of unattached Fucus spp. (dwarf form)?
YES
AA.M1Q2 Baltic photic mixed substrate dominated by stable aggregations of unattached Fucus spp. (dwarf form)
NO
≥50% biovolume Furcellaria lumbricalis?
YES
AA.M1Q3 Baltic photic mixed substrate dominated by stable aggregations of unattached Furcellaria lumbricalis
NO
≥50% biovolume rigid hornwort?
YES
AA.M1Q4 Baltic photic mixed substrate dominated by stable aggregations of unattached rigid hornwort (Ceratophyllum demersum)
NO, stop at Level 5
From page 58
AA.M1S Baltic photic mixed substrate characterized by annual algae
≥50% biovolume filamentous annual algae?
YES
AA.M1S1 Baltic photic mixed substrate dominated by filamentous annual algae
NO
≥50% biomass Chorda filum and/or Halosiphon tomentosus
YES
AA.M1S2 Baltic photic mixed substrate dominated by Chorda filum and/or Halosiphon tomentosus
NO, stop at Level 5

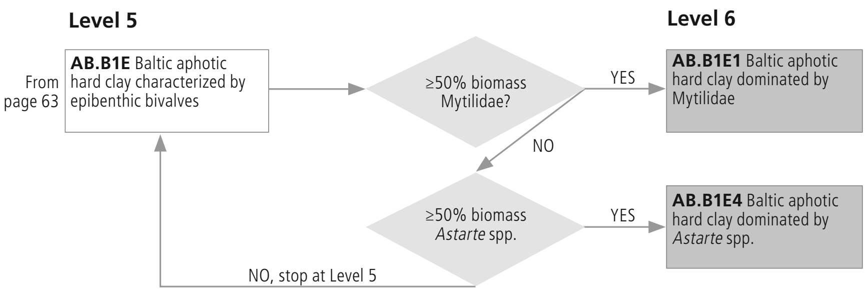


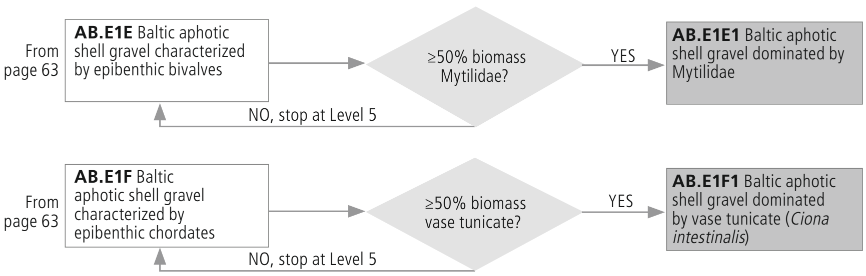
Level 3
Level 4
Level 5
From page 43
AB.A Baltic aphotic rock and boulders
≥10% coverage of sessile macroscopic epifauna?
YES
NO
AB.A1 Baltic aphotic rock and boulder characterized by macroscopic epibenthic biotic structures
Does any Perennial attached erect group have ≥10% coverage
YES
NO
Select the dominant group (of the groups ≥10% coverage)
Bivalves
AB.A1E Baltic aphotic rock and boulders characterized by epibenthic bivalves
Go to page 62
Chordates
AB.A1F Baltic aphotic rock and boulders characterized by epibenthic chordates
Go to page 62
Cnidaraians
AB.A1G Baltic aphotic rock and boulders characterized by epibenthic cnidarians
Go to page 62
Moss animals
AB.A1H Baltic aphotic rock and boulders characterized by epibenthic moss animals (Bryozoa)
Go to page 62
Crustaceans
AB.A1I Baltic aphotic rock and boulders characterized by epibenthic crustacea
Go to page 62
Sponges
AB.A1J Baltic aphotic rock and boulders characterized by epibenthic sponges (Porifera)
AB.A1V Baltic aphotic rock and boulder characterized by mixed epibenthic macrocommunity
0><10% coverage of sessile macroscopic epifauna
YES
NO
AB.A2 Baltic aphotic rock and boulder characterized by sparse macroscopic epibenthic biotic structures
AB.A2T Baltic aphotic rock and boulders characterized by sparse epibenthic macrocommunity
No macro- epi- or infauna
YES
AB.A4 Baltic aphotic rock and boulder characterized by no macroscopic biotic structures
AB.A4U Baltic aphotic rock and boulders characterized by no macrocommunity

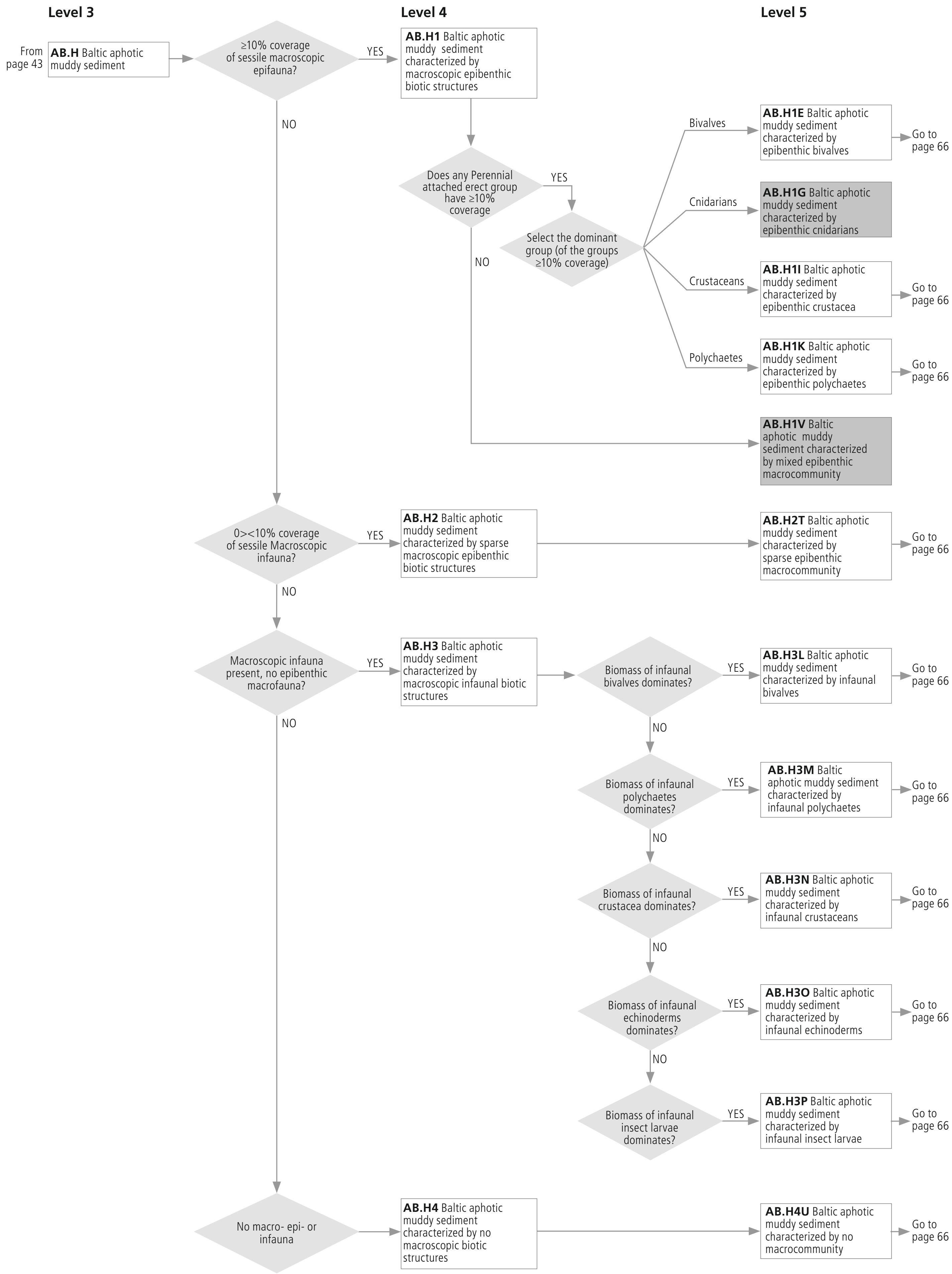

Level 5
Level 6
From page 61
AB.A1E Baltic aphotic rock and boulders characterized by epibenthic bivalves
≥50% biomass Mytilidae?
YES
AB.A1E1 Baltic aphotic rock and boulder dominated by Mytilidae
NO, stop at Level 5
From page 61
AB.A1F Baltic aphotic rock and boulders characterized by epibenthic chordates
≥50% biomass sea squirts?
YES
AB.A1F1 Baltic aphotic rock and boulders dominated by sea squirts (Ascidiacea)
NO, stop at Level 5
From page 61
AB.A1G Baltic aphotic rock and boulders characterized by epibenthic cnidarians
≥50% biomass hydroids?
YES
AB.A1G1 Baltic aphotic rock and boulders dominated by hydroids (Hydrozoa)
NO
≥50% biomass sea anemones?
YES
AB.A1G2 Baltic aphotic rock and boulders dominated by sea anemones (Actiniarida)
NO
≥50% biomass stone corals?
YES
AB.A1G3 Baltic aphotic rock and boulders dominated stone corals (Scleractinida)
NO
≥50% biomass soft corals?
YES
AB.A1G4 Baltic aphotic rock and boulders dominated by soft corals (Alcyonacea)
NO, stop at Level 5
From page 61
AB.A1H Baltic aphotic rock and boulders characterized by epibenthic moss animals (Bryozoa)
≥50% biomass corticated moss animals?
YES
AB.A1H1 Baltic aphotic rock and boulders dominated by corticated moss animals (Electra crustulenta)
NO
≥50% biomass erect moss animals?
YES
AB.A1H2 Baltic aphotic rock and boulders dominated by erect moss animals (Flustra foliacea)
NO, stop at Level 5
From page 61
AB.A1I Baltic aphotic rock and boulders characterized by epibenthic crustacea
≥50% biomass barnacles?
YES
AB.A1I1 Baltic aphotic rock and boulders dominated by barnacles (Balanidae)
NO, stop at Level 5

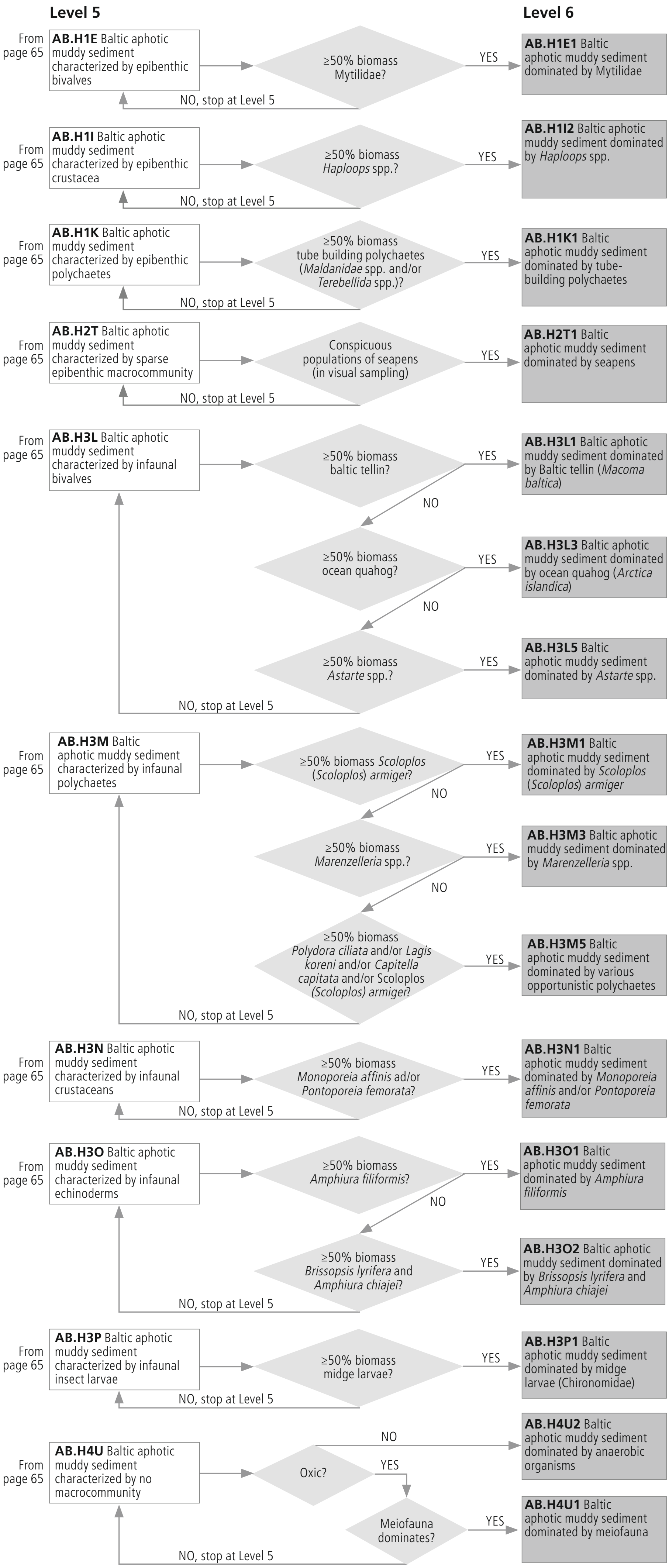


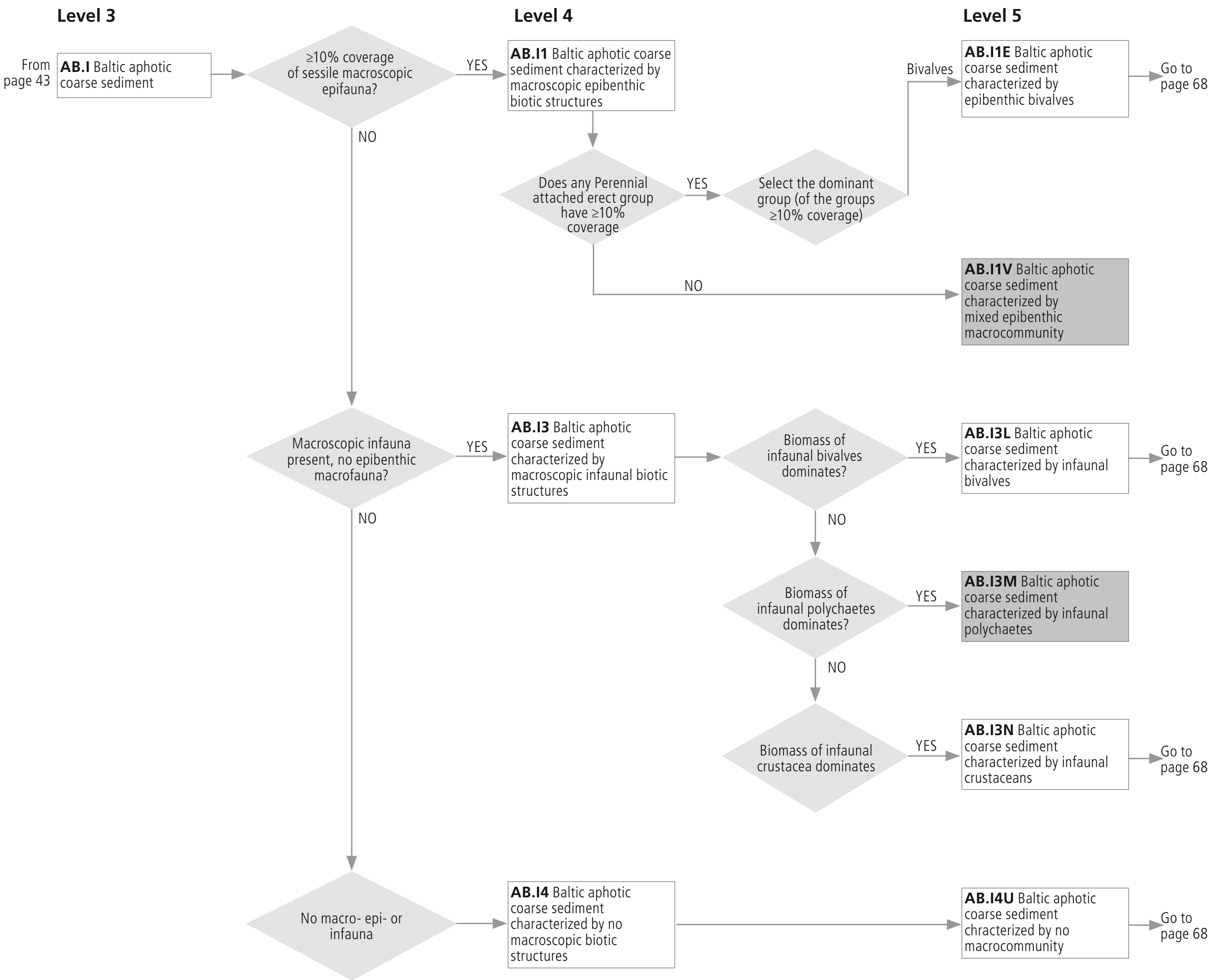
Level 3
Level 4
Level 5
From page 43
AB.B Baltic aphotic hard clay
≥10% coverage of sessile macroscopic epifauna?
YES
AB.B1 Baltic aphotic hard clay characterized by macroscopic epibenthic biotic structures
Bivalves
AB.B1E Baltic aphotic hard clay characterized by epibenthic bivalves
Go to page 64
NO
Does any Perennial attached erect group have ≥10% coverage
YES
Select the dominant group (of the groups ≥10% coverage)
NO
AB.B1V Baltic aphotic hard clay characterized by mixed epibenthic macrocommunity
0><10% coverage of sessile macroscopic epifauna?
YES
AB.B2 Baltic aphotic hard clay characterized by sparse macroscopic epibenthic biotic structures
AB.B2T Baltic aphotic hard clay characterized by sparse epibenthic macrocommunity
NO
No macro- epi- or infauna
YES
AB.B4 Baltic aphotic hard clay characterized by no macroscopic biotic structures
AB.B4U Baltic aphotic hard clay characterized by no macrocommunity
From page 43
AB.E Baltic aphotic shell gravel
≥10% coverage of sessile macroscopic epifauna?
YES
AB.E1 Baltic aphotic shell gravel characterized by macroscopic epibenthic biotic structures
NO
Does any Perennial attached erect group have ≥ 10% coverage
YES
Select the dominant group (of the groups ≥10% coverage)
Bivalves
AB.E1E Baltic aphotic shell gravel characterized by epibenthic bivalves
Go to page 64
NO
Chordates
AB.E1F Baltic aphotic shell gravel characterized by epibenthic chordates
Go to page 64
AB.E1V Baltic aphotic shell gravel characterized by mixed epibenthic macrocommunity
0><10% coverage of sessile macroscopic epifauna?
YES
AB.E2 Baltic aphotic shell gravel characterized by sparse macroscopic epibenthic biotic structures
AB.E2T Baltic aphotic shell gravel characterized by sparse epibenthic macrocommunity
NO
Macroscopic infauna present, no epibenthic macrofauna?
YES
Only for biotopes occuring in Kattegat and the most southern parts of the Baltic Sea (Mytilus shell gravel in Norhten Baltic Sea, should be classified AB.E1E1)
AB.E3 Baltic aphotic shell gravel characterized by macroscopic infaunal biotic structures
Select dominant type of shell gravel fragments
AB.E3X Baltic aphotic shell gravel characterized by mixed infaunal macrocommunity in coarse and well-sorted shells and shell fragments
AB.E3Y Baltic aphotic shell gravel characterized by mixed infaunal macrocommunity in fine sand-like shell fragments
NO
No macro- epi- or infauna
YES
AB.E4 Baltic aphotic shell gravel characterized by no macroscopic biotic structures
AB.E4U Baltic aphotic shell gravel characterized by no macrocommunity

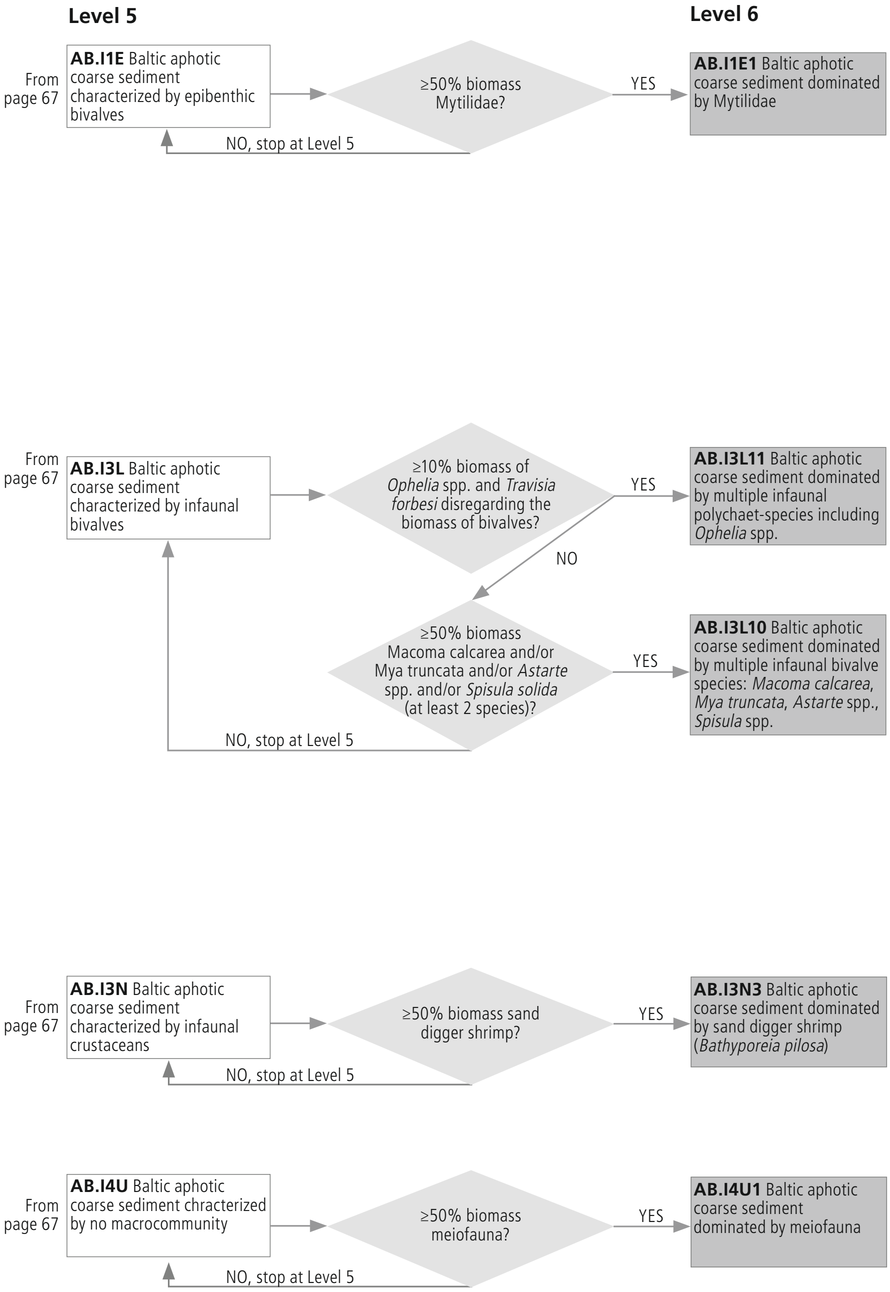

Level 5
Level 6
From page 63
AB.B1E Baltic aphotic hard clay characterized by epibenthic bivalves
≥50% biomass Mytilidae?
YES
AB.B1E1 Baltic aphotic hard clay dominated by Mytilidae
NO
≥50% biomass Astarte spp.
YES
AB.B1E4 Baltic aphotic hard clay dominated by Astarte spp.
NO, stop at Level 5

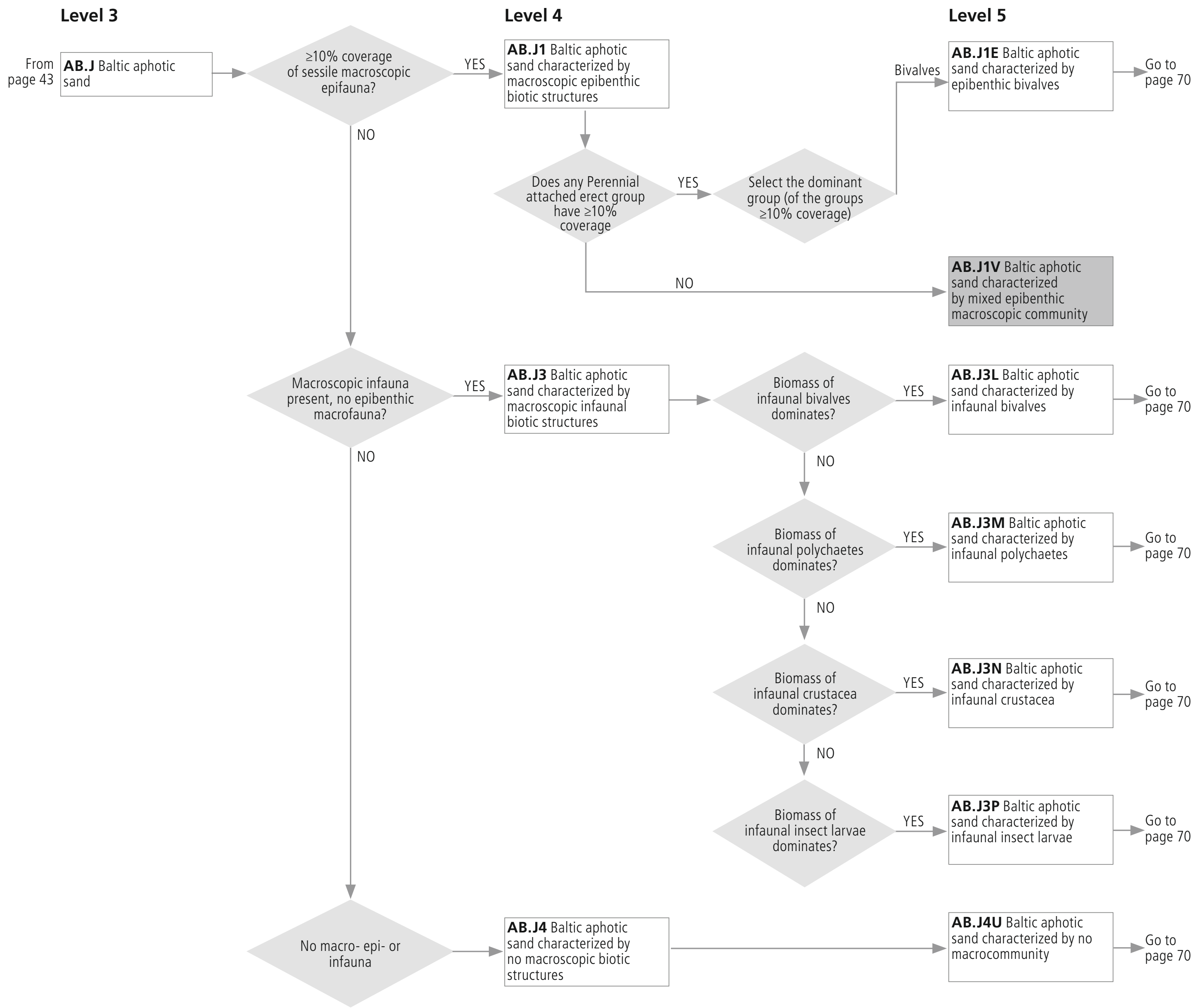

From page 63
AB.E1E Baltic aphotic shell gravel characterized by epibenthic bivalves
≥50% biomass Mytilidae?
YES
AB.E1E1 Baltic aphotic shell gravel dominated by Mytilidae
NO, stop at Level 5
From page 63
AB.E1F Baltic aphotic shell gravel characterized by epibenthic chordates
≥50% biomass vase tunicate?
YES
AB.E1F1 Baltic aphotic shell gravel dominated by vase tunicate (Ciona intestinalis)
NO, stop at Level 5

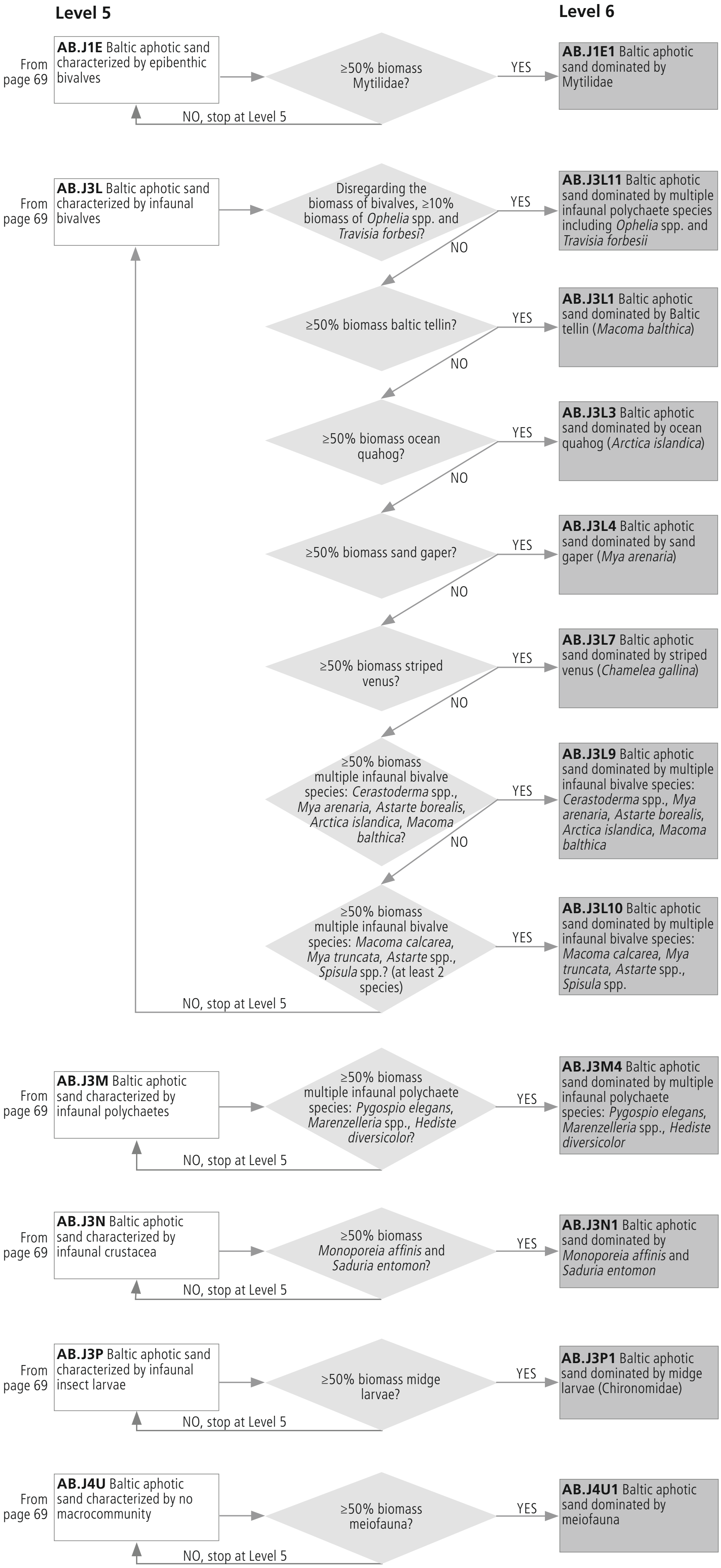

Level 3
Level 4
Level 5
From page 43
AB.H Baltic aphotic muddy sediment
≥10% coverage of sessile macroscopic epifauna?
YES
AB.H1 Baltic aphotic muddy sediment characterized by macroscopic epibenthic biotic structures
Does any Perennial attached erect group have ≥10% coverage
YES
Select the dominant group (of the groups ≥10% coverage)
Bivalves
AB.H1E Baltic aphotic muddy sediment characterized by epibenthic bivalves
Go to page 66
Cnidarians
AB.H1G Baltic aphotic muddy sediment characterized by epibenthic cnidarians
Crustaceans
AB.H1I Baltic aphotic muddy sediment characterized by epibenthic crustacea
Go to page 66
Polychaetes
AB.H1K Baltic aphotic muddy sediment characterized by epibenthic polychaetes
Go to page 66
NO
AB.H1V Baltic aphotic muddy sediment characterized by mixed epibenthic macrocommunity
NO
0><10% coverage of sessile Macroscopic infauna?
YES
AB.H2 Baltic aphotic muddy sediment characterized by sparse macroscopic epibenthic biotic structures
AB.H2T Baltic aphotic muddy sediment characterized by sparse epibenthic macrocommunity
Go to page 66
NO
Macroscopic infauna present, no epibenthic macrofauna?
YES
AB.H3 Baltic aphotic muddy sediment characterized by macroscopic infaunal biotic structures
Biomass of infaunal bivalves dominates?
YES
AB.H3L Baltic aphotic muddy sediment characterized by infaunal bivalves
Go to page 66
NO
Biomass of infaunal polychaetes dominates?
YES
AB.H3M Baltic aphotic muddy sediment characterized by infaunal polychaetes
Go to page 66
NO
Biomass of infaunal crustacea dominates?
YES
AB.H3N Baltic aphotic muddy sediment characterized by infaunal crustaceans
Go to page 66
NO
Biomass of infaunal echinoderms dominates?
YES
AB.H3O Baltic aphotic muddy sediment characterized by infaunal echinoderms
Go to page 66
NO
Biomass of infaunal insect larvae dominates?
YES
AB.H3P Baltic aphotic muddy sediment characterized by infaunal insect larvae
Go to page 66
NO
No macro- epi- or infauna
AB.H4 Baltic aphotic muddy sediment characterized by no macroscopic biotic structures
AB.H4U Baltic aphotic muddy sediment characterized by no macrocommunity
Go to page 66

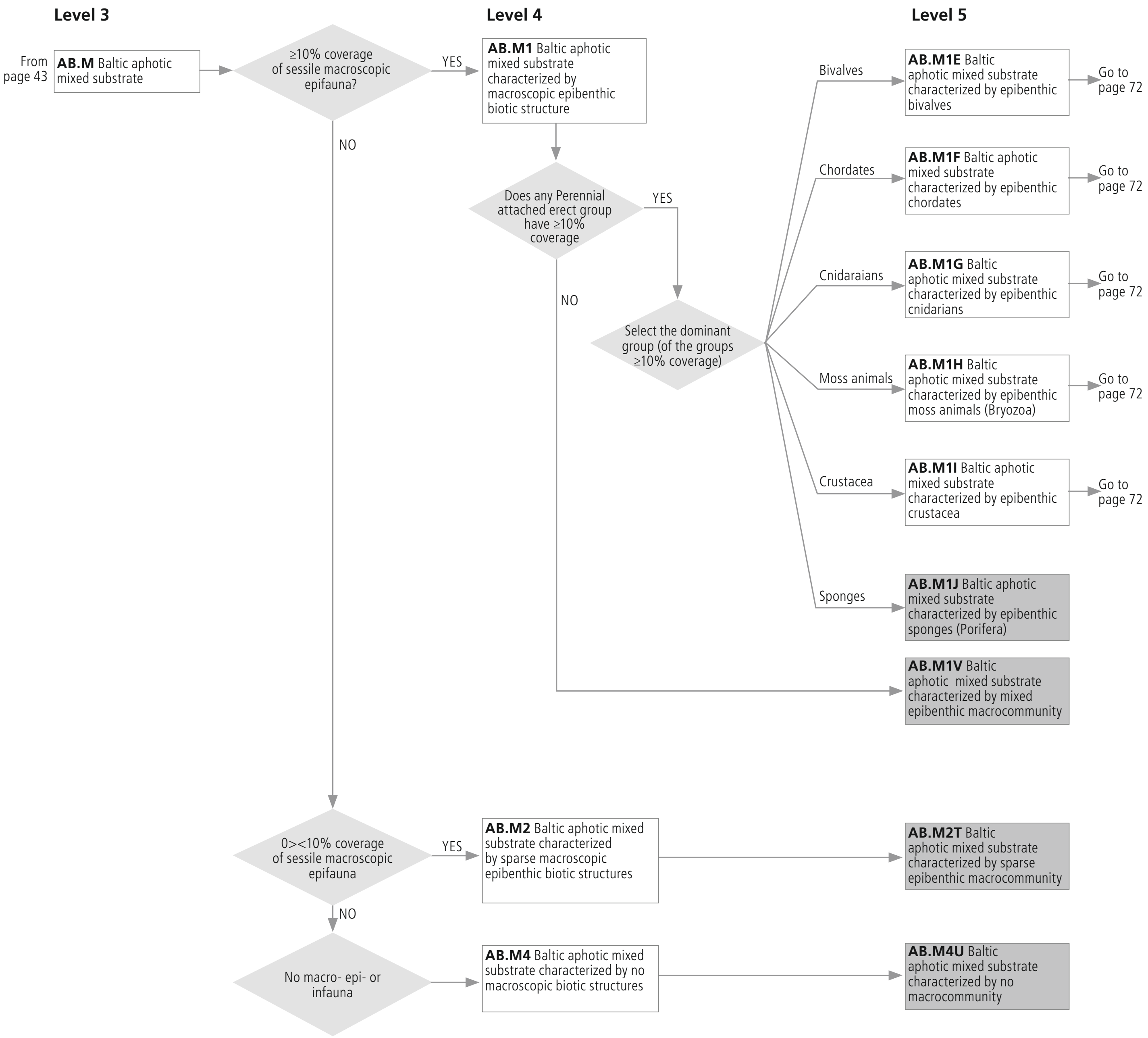

Level 5
Level 6
From page 65
AB.H1E Baltic aphotic muddy sediment characterized by epibenthic bivalves
≥50% biomass Mytilidae?
YES
AB.H1E1 Baltic aphotic muddy sediment dominated by Mytilidae
NO, stop at Level 5
From page 65
AB.H1I Baltic aphotic muddy sediment characterized by epibenthic crustacea
≥50% biomass Haploops spp.?
YES
AB.H1I2 Baltic aphotic muddy sediment dominated by Haploops spp.
NO, stop at Level 5
From page 65
AB.H1K Baltic aphotic muddy sediment characterized by epibenthic polychaetes
≥50% biomass tube building polychaetes (Maldanidae spp. and/or Terebellida spp.)?
YES
AB.H1K1 Baltic aphotic muddy sediment dominated by tube-building polychaetes
NO, stop at Level 5
From page 65
AB.H2T Baltic aphotic muddy sediment characterized by sparse epibenthic macrocommunity
Conspicuous populations of seapens (in visual sampling)
YES
AB.H2T1 Baltic aphotic muddy sediment dominated by seapens
NO, stop at Level 5
From page 65
AB.H3L Baltic aphotic muddy sediment characterized by infaunal bivalves
≥50% biomass baltic tellin?
YES
AB.H3L1 Baltic aphotic muddy sediment dominated by Baltic tellin (Macoma baltica)
NO
≥50% biomass ocean quahog?
YES
AB.H3L3 Baltic aphotic muddy sediment dominated by ocean quahog (Arctica islandica)
NO
≥50% biomass Astarte spp.?
YES
AB.H3L5 Baltic aphotic muddy sediment dominated by Astarte spp.
NO, stop at Level 5
From page 65
AB.H3M Baltic aphotic muddy sediment characterized by infaunal polychaetes
≥50% biomass Scoloplos (Scoloplos) armiger?
YES
AB.H3M1 Baltic aphotic muddy sediment dominated by Scoloplos (Scoloplos) armiger
NO
≥50% biomass Marenzelleria spp.?
YES
AB.H3M3 Baltic aphotic muddy sediment dominated by Marenzelleria spp.
NO
≥50% biomass Polydora ciliata and/or Lagis koreni and/or Capitella capitata and/or Scoloplos (Scoloplos) armiger?
YES
AB.H3M5 Baltic aphotic muddy sediment dominated by various opportunistic polychaetes
NO, stop at Level 5
From page 65
AB.H3N Baltic aphotic muddy sediment characterized by infaunal crustaceans
≥50% biomass Monoporeia affinis ad/or Pontoporeia femorata?
YES
AB.H3N1 Baltic aphotic muddy sediment dominated by Monoporeia affinis and/or Pontoporeia femorata
NO, stop at Level 5
From page 65
AB.H3O Baltic aphotic muddy sediment characterized by infaunal echinoderms
≥50% biomass Amphiura filiformis?
YES
AB.H3O1 Baltic aphotic muddy sediment dominated by Amphiura filiformis
NO
≥50% biomass Brissopsis lyrifera and Amphiura chiajei?
YES
AB.H3O2 Baltic aphotic muddy sediment dominated by Brissopsis lyrifera and Amphiura chiajei
NO, stop at Level 5
From page 65
AB.H3P Baltic aphotic muddy sediment characterized by infaunal insect larvae
≥50% biomass midge larvae?
YES
AB.H3P1 Baltic aphotic muddy sediment dominated by midge larvae (Chironomidae)
NO, stop at Level 5
From page 65
AB.H4U Baltic aphotic muddy sediment characterized by no macrocommunity
Oxic?
NO
AB.H4U2 Baltic aphotic muddy sediment dominated by anaerobic organisms
YES
Meiofauna dominates?
YES
AB.H4U1 Baltic aphotic muddy sediment dominated by meiofauna
NO, stop at Level 5


Level 3
Level 4
Level 5
From page 43
AB.I Baltic aphotic coarse sediment
≥10% coverage of sessile macroscopic epifauna?
YES
NO
AB.I1 Baltic aphotic coarse sediment characterized by macroscopic epibenthic biotic structures
Does any Perennial attached erect group have ≥10% coverage
YES
Select the dominant group (of the groups ≥10% coverage)
Bivalves
AB.I1E Baltic aphotic coarse sediment characterized by epibenthic bivalves
Go to page 68
NO
AB.I1V Baltic aphotic coarse sediment characterized by mixed epibenthic macrocommunity
Macroscopic infauna present, no epibenthic macrofauna?
YES
NO
AB.I3 Baltic aphotic coarse sediment characterized by macroscopic infaunal biotic structures
Biomass of infaunal bivalves dominates?
YES
AB.I3L Baltic aphotic coarse sediment characterized by infaunal bivalves
Go to page 68
NO
Biomass of infaunal polychaetes dominates?
YES
AB.I3M Baltic aphotic coarse sediment characterized by infaunal polychaetes
NO
Biomass of infaunal crustacea dominates
YES
AB.I3N Baltic aphotic coarse sediment characterized by infaunal crustaceans
Go to page 68
No macro- epi- or infauna
AB.I4 Baltic aphotic coarse sediment characterized by no macroscopic biotic structures
AB.I4U Baltic aphotic coarse sediment chracterized by no macrocommunity
Go to page 68

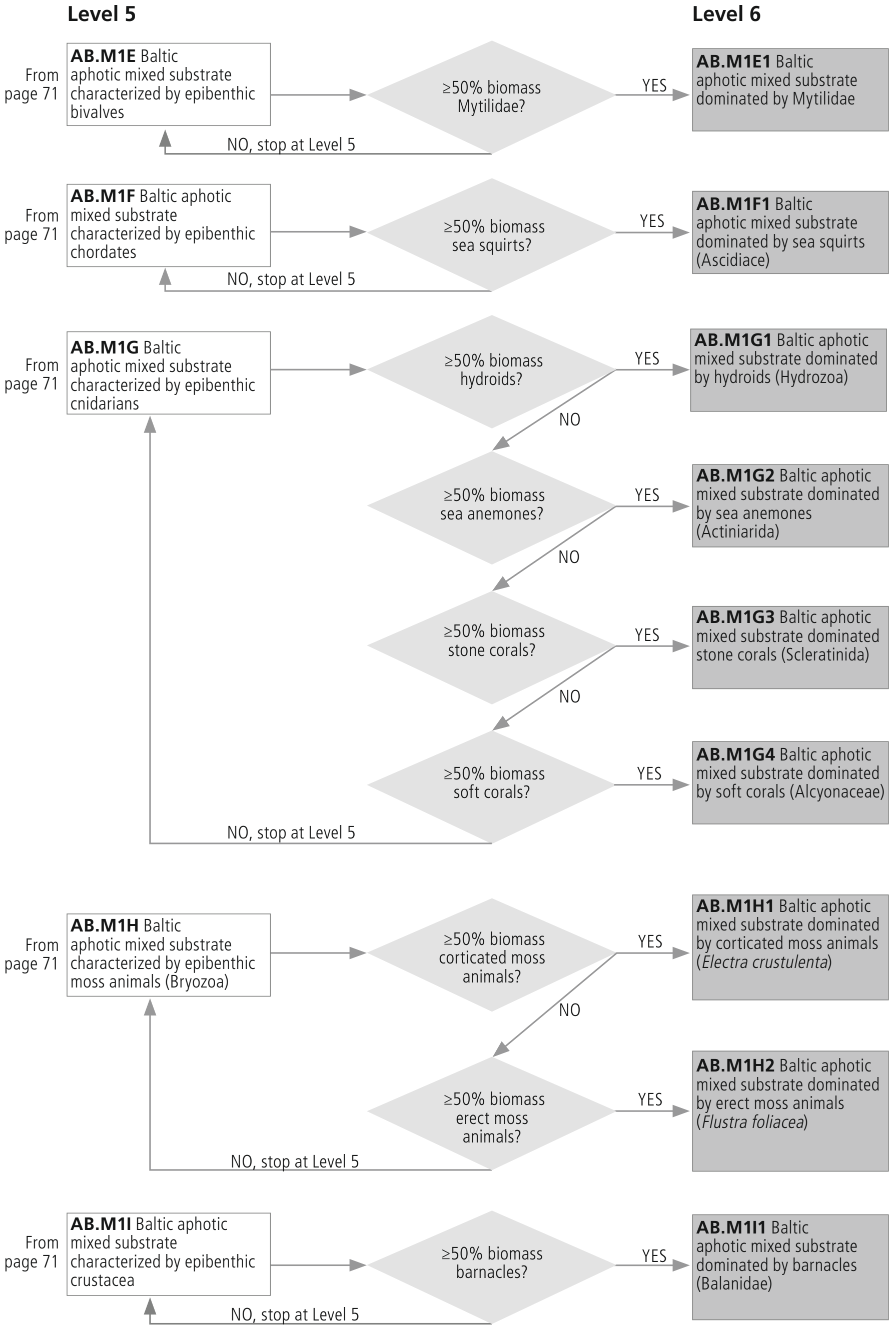

Level 5
Level 6
From page 67
AB.I1E Baltic aphotic coarse sediment characterized by epibenthic bivalves
≥50% biomass Mytilidae?
YES
AB.I1E1 Baltic aphotic coarse sediment dominated by Mytilidae
NO, stop at Level 5
From page 67
AB.I3L Baltic aphotic coarse sediment characterized by infaunal bivalves
≥10% biomass of Ophelia spp. and Travisia forbesi disregarding the biomass of bivalves?
YES
AB.I3L11 Baltic aphotic coarse sediment dominated by multiple infaunal polychaet-species including Ophelia spp.
NO
≥50% biomass Macoma calcarea and/or Mya truncata and/or Astarte spp. and/or Spisula solida (at least 2 species)?
YES
AB.I3L10 Baltic aphotic coarse sediment dominated by multiple infaunal bivalve species: Macoma calcarea, Mya truncata, Astarte spp., Spisula spp.
NO, stop at Level 5
From page 67
AB.I3N Baltic aphotic coarse sediment characterized by infaunal crustaceans
≥50% biomass sand digger shrimp?
YES
AB.I3N3 Baltic aphotic coarse sediment dominated by sand digger shrimp (Bathyporeia pilosa)
NO, stop at Level 5
From page 67
AB.I4U Baltic aphotic coarse sediment chracterized by no macrocommunity
≥50% biomass meiofauna?
YES
AB.I4U1 Baltic aphotic coarse sediment dominated by meiofauna
NO, stop at Level 5


Level 3
Level 4
Level 5
From page 43
AB.J Baltic aphotic sand
≥10% coverage of sessile macroscopic epifauna?
YES
NO
AB.J1 Baltic aphotic sand characterized by macroscopic epibenthic biotic structures
Does any Perennial attached erect group have ≥10% coverage
YES
Select the dominant group (of the groups ≥10% coverage)
Bivalves
AB.J1E Baltic aphotic sand characterized by epibenthic bivalves
Go to page 70
NO
AB.J1V Baltic aphotic sand characterized by mixed epibenthic macroscopic community
Macroscopic infauna present, no epibenthic macrofauna?
YES
NO
AB.J3 Baltic aphotic sand characterized by macroscopic infaunal biotic structures
Biomass of infaunal bivalves dominates?
YES
AB.J3L Baltic aphotic sand characterized by infaunal bivalves
Go to page 70
NO
Biomass of infaunal polychaetes dominates?
YES
AB.J3M Baltic aphotic sand characterized by infaunal polychaetes
Go to page 70
NO
Biomass of infaunal crustacea dominates?
YES
AB.J3N Baltic aphotic sand characterized by infaunal crustacea
Go to page 70
NO
Biomass of infaunal insect larvae dominates?
YES
AB.J3P Baltic aphotic sand characterized by infaunal insect larvae
Go to page 70
No macro- epi- or infauna
AB.J4 Baltic aphotic sand characterized by no macroscopic biotic structures
AB.J4U Baltic aphotic sand characterized by no macrocommunity
Go to page 70


Level 5
Level 6
From page 69
AB.J1E Baltic aphotic sand characterized by epibenthic bivalves
≥50% biomass Mytilidae?
YES
AB.J1E1 Baltic aphotic sand dominated by Mytilidae
NO, stop at Level 5
From page 69
AB.J3L Baltic aphotic sand characterized by infaunal bivalves
Disregarding the biomass of bivalves, ≥10% biomass of Ophelia spp. and Travisia forbesi?
YES
AB.J3L11 Baltic aphotic sand dominated by multiple infaunal polychaete species including Ophelia spp. and Travisia forbesii
NO
≥50% biomass baltic tellin?
YES
AB.J3L1 Baltic aphotic sand dominated by Baltic tellin (Macoma balthica)
NO
≥50% biomass ocean quahog?
YES
AB.J3L3 Baltic aphotic sand dominated by ocean quahog (Arctica islandica)
NO
≥50% biomass sand gaper?
YES
AB.J3L4 Baltic aphotic sand dominated by sand gaper (Mya arenaria)
NO
≥50% biomass striped venus?
YES
AB.J3L7 Baltic aphotic sand dominated by striped venus (Chamelea gallina)
NO
≥50% biomass multiple infaunal bivalve species: Cerastoderma spp., Mya arenaria, Astarte borealis, Arctica islandica, Macoma balthica?
YES
AB.J3L9 Baltic aphotic sand dominated by multiple infaunal bivalve species: Cerastoderma spp., Mya arenaria, Astarte borealis, Arctica islandica, Macoma balthica
NO
≥50% biomass multiple infaunal bivalve species: Macoma calcarea, Mya truncata, Astarte spp., Spisula spp.? (at least 2 species)
YES
AB.J3L10 Baltic aphotic sand dominated by multiple infaunal bivalve species: Macoma calcarea, Mya truncata, Astarte spp., Spisula spp.
NO, stop at Level 5
From page 69
AB.J3M Baltic aphotic sand characterized by infaunal polychaetes
≥50% biomass multiple infaunal polychaete species: Pygospio elegans, Marenzelleria spp., Hediste diversicolor?
YES
AB.J3M4 Baltic aphotic sand dominated by multiple infaunal polychaete species: Pygospio elegans, Marenzelleria spp., Hediste diversicolor
NO, stop at Level 5
From page 69
AB.J3N Baltic aphotic sand characterized by infaunal crustacea
≥50% biomass Monoporeia affinis and Saduria entomon?
YES
AB.J3N1 Baltic aphotic sand dominated by Monoporeia affinis and Saduria entomon
NO, stop at Level 5
From page 69
AB.J3P Baltic aphotic sand characterized by infaunal insect larvae
≥50% biomass midge larvae?
YES
AB.J3P1 Baltic aphotic sand dominated by midge larvae (Chironomidae)
NO, stop at Level 5
From page 69
AB.J4U Baltic aphotic sand characterized by no macrocommunity
≥50% biomass meiofauna?
YES
AB.J4U1 Baltic aphotic sand dominated by meiofauna
NO, stop at Level 5



Level 3
Level 4
Level 5
From page 43
AB.M Baltic aphotic mixed substrate
≥10% coverage of sessile macroscopic epifauna?
YES
NO
AB.M1 Baltic aphotic mixed substrate characterized by macroscopic epibenthic biotic structure
Does any Perennial attached erect group have ≥10% coverage
YES
NO
Select the dominant group (of the groups ≥10% coverage)
Bivalves
AB.M1E Baltic aphotic mixed substrate characterized by epibenthic bivalves
Go to page 72
Chordates
AB.M1F Baltic aphotic mixed substrate characterized by epibenthic chordates
Go to page 72
Cnidaraians
AB.M1G Baltic aphotic mixed substrate characterized by epibenthic cnidarians
Go to page 72
Moss animals
AB.M1H Baltic aphotic mixed substrate characterized by epibenthic moss animals (Bryozoa)
Go to page 72
Crustacea
AB.M1I Baltic aphotic mixed substrate characterized by epibenthic crustacea
Go to page 72
Sponges
AB.M1J Baltic aphotic mixed substrate characterized by epibenthic sponges (Porifera)
AB.M1V Baltic aphotic mixed substrate characterized by mixed epibenthic macrocommunity
0><10% coverage of sessile macroscopic epifauna
YES
NO
AB.M2 Baltic aphotic mixed substrate characterized by sparse macroscopic epibenthic biotic structures
AB.M2T Baltic aphotic mixed substrate characterized by sparse epibenthic macrocommunity
No macro- epi- or infauna
AB.M4 Baltic aphotic mixed substrate characterized by no macroscopic biotic structures
AB.M4U Baltic aphotic mixed substrate characterized by no macrocommunity


Level 5
Level 6
From page 71
AB.M1E Baltic aphotic mixed substrate characterized by epibenthic bivalves
≥50% biomass Mytilidae?
YES
AB.M1E1 Baltic aphotic mixed substrate dominated by Mytilidae
NO, stop at Level 5
From page 71
AB.M1F Baltic aphotic mixed substrate characterized by epibenthic chordates
≥50% biomass sea squirts?
YES
AB.M1F1 Baltic aphotic mixed substrate dominated by sea squirts (Ascidiace)
NO, stop at Level 5
From page 71
AB.M1G Baltic aphotic mixed substrate characterized by epibenthic cnidarians
≥50% biomass hydroids?
YES
AB.M1G1 Baltic aphotic mixed substrate dominated by hydroids (Hydrozoa)
NO
≥50% biomass sea anemones?
YES
AB.M1G2 Baltic aphotic mixed substrate dominated by sea anemones (Actiniarida)
NO
≥50% biomass stone corals?
YES
AB.M1G3 Baltic aphotic mixed substrate dominated stone corals (Scleratinida)
NO
≥50% biomass soft corals?
YES
AB.M1G4 Baltic aphotic mixed substrate dominated by soft corals (Alcyonaceae)
NO, stop at Level 5
From page 71
AB.M1H Baltic aphotic mixed substrate characterized by epibenthic moss animals (Bryozoa)
≥50% biomass corticated moss animals?
YES
AB.M1H1 Baltic aphotic mixed substrate dominated by corticated moss animals (*Electra crustulenta*)
NO
≥50% biomass erect moss animals?
YES
AB.M1H2 Baltic aphotic mixed substrate dominated by erect moss animals (*Flustra foliacea*)
NO, stop at Level 5
From page 71
AB.M1I Baltic aphotic mixed substrate characterized by epibenthic crustacea
≥50% biomass barnacles?
YES
AB.M1I1 Baltic aphotic mixed substrate dominated by barnacles (Balanidae)
NO, stop at Level 5

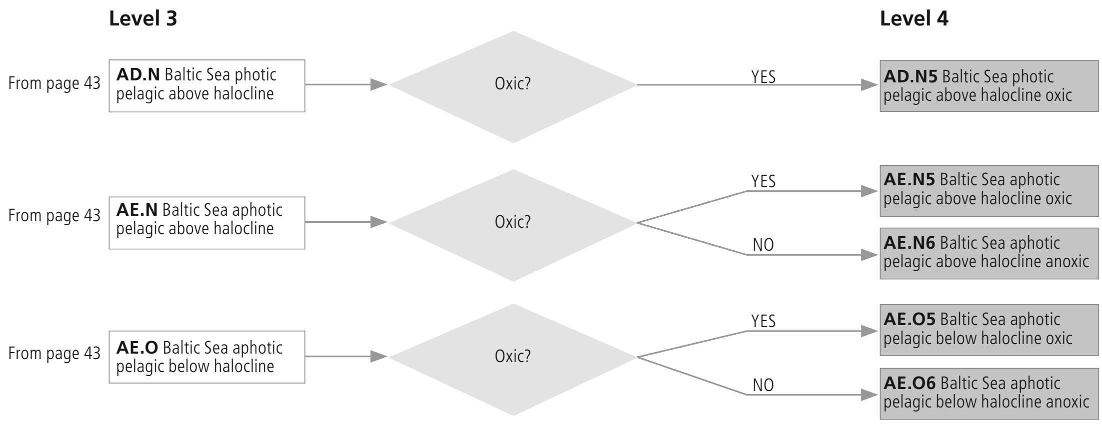

Level 3
Level 4
From page 43
AD.N Baltic Sea photic pelagic above halocline
Oxic?
YES
AD.N5 Baltic Sea photic pelagic above halocline oxic
From page 43
AE.N Baltic Sea aphotic pelagic above halocline
Oxic?
YES
NO
AE.N5 Baltic Sea aphotic pelagic above halocline oxic
AE.N6 Baltic Sea aphotic pelagic above halocline anoxic
From page 43
AE.O Baltic Sea aphotic pelagic below halocline
Oxic?
YES
NO
AE.O5 Baltic Sea aphotic pelagic below halocline oxic
AE.O6 Baltic Sea aphotic pelagic below halocline anoxic

Table 4. Key to reading the code of biotopes in HUB, the table is not to be used for creating 'new' biotopes by selecting one feature from each level.

Level 1 'region'	Level 2 'vertical zones'	Level 3 'substrate'	Level 4 'community structure'	Level 5 'characteristic community'	Level 6 'dominating taxa'
A. Baltic	A. photic benthos B. aphotic benthos C. seasonal sea ice D. photic pelagic E. aphotic pelagic	A. rock and boulder B. hard clay C. marl D. maërl beds E. shell gravel F. ferro-manganese concretion bottom G. peat H. mud I. coarse sediment J. sand K. hard anthropogenically created substrates L. soft anthropogenically created substrates M. mixed substrate N. above halocline (pelagic) O. below halocline (pelagic)	1. macroscopic epibenthic biotic structures 2. sparse macroscopic epibenthic biotic structures 3. macroscopic infaunal biotic structures 4. no macroscopic biotic structures 5. oxic (pelagic) 6. anoxic (pelagic)	A. emergent vegetation	1. *Phragmites australis* 2. Cyperaceae
				C. submerged rooted plants	1. *Potamogeton perfoliatus* and/or Stuckenia pectinata 2. *Zannichellia* spp. and/or *Ruppia* spp. and/or *Zostera noltii* 3. *Myriophyllum spicatum* and/or *Myriophyllum sibiricum* 4. Charales 5. *Najas marina* 6. *Ranunculus* spp. 7. *Zostera marina* 8. *Eleocharis* spp.
				I. perennial algae	1. *Fucus* spp. 2. non-filamentous corticated red algae 3. foliose red algae 4. kelp 5. filamentous algae
				F. aquatic moss	
				G. epibenthic bivalves	1. Mytilidae 2. *Dreissena polymorpha* 3. *Valvata* spp. 4. *Astarte* spp.
				E. epibenthic chordates	1. *Ascidiacea* / vase tunicate
				B. epibenthic cnidarians	1. Hydrozoa 2. Actiniarida 3. Scleratinida 4. Alcyonacea 5. seapens
				F. epibenthic moss animals	1. crustose moss animals (Electra crustulenta) 2. erect moss animals (Flustra foliaceae)
				C. epibenthic crustaceans	1. Balanidae 2. *Haploops* spp.
				C. epibenthic sponges	
				D. epibenthic polychaetes	1. tube building polychaetes
				B. infaunal bivalves	1. *Macoma baltica* 2. *Cerastoderma* spp. 3. *Arctica* spp. 4. *Mya arenaria* 5. *Astarte* spp. 6. Unionidae 7. *Chamelea gallina* 8. *Abra* spp. 9. multiple infaunal bivalve species: *Cerastoderma* spp., *Mya arenaria, Astarte borealis, Arctica islandica, Macoma balthica* 10. multiple infaunal bivalve species: *Macoma calcarea, Mya truncata, Astarte spp., Spisula* spp. 11. *Ophelia* spp. and *Travisia* spp. polychetes ≥ 10% biomass when disregarding biomass of present bivalves

Level 1 'region'	Level 2 'vertical zones'	Level 3 'substrate'	Level 4 'community structure'	Level 5 'characteristic community'	Level 6 'dominating taxa'
A. Baltic	A. photic benthos B. aphotic benthos C. seasonal sea ice D. photic pelagic E. aphotic pelagic	A. rock and boulder B. hard clay C. marl D. maërl beds E. shell gravel F. ferro-manganese concretion bottom G. peat H. mud I. coarse sediment J. sand K. hard anthropogenically created substrates L. soft anthropogenically created substrates M. mixed substrate N. above halocline (pelagic) O. below halocline (pelagic)	1. macroscopic epibenthic biotic structures 2. sparse macroscopic epibenthic biotic structures 3. macroscopic infaunal biotic structures 4. no macroscopic biotic structures 5. oxic (pelagic) 6. anoxic (pelagic)	M. infaunal polychaetes	1. *Scoloplos armiger* 2. lugworm 3. *Marenzelleria* spp. 4. multiple infaunal polychaete species: *Pygospio elegans, Marenzelleria spp., Hediste diversicolor* 5. various opportunistic polychaetes
				F. infaunal crustaceans	1. *Monoporeia affinis* 2. *Corophium* spp. 3. *Bathyporeia* spp.
				D. infaunal echinoderms	1. *Amphiura spp.* 2. *Brissopsis* spp.
				C. infaunal insect larvae	1. Chironomidae
				B. stable aggregations of unattached perennial vegetation	1. *Fucus* spp. typical form 2. *Fucus* spp. dwarf form 3. *Furcellaria lumbricalis* 4. *Ceratophyllum demersum* 5. *Aegagropila* linnaei
				F. soft crustose algae	
				G. annual algae	1. filamentous annual algae 2. *Chorda filum* and/or *Halosiphon tomentosus* 3. *Vaucheria* spp.
				D. sparse epibenthic communities	
				E. no macrocommunity	1. meiofauna 2. anaerobic organisms
				C. mixed epibenthic macrocommunity	
				D. Microphytobenthic organisms and grazing snails E. mixed infaunal macrocommunity in coarse and well-sorted shells and shell fragments	
				F. mixed infaunal macrocommunity in fine sand-like shell fragments	

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List of abbreviations

BalMar - Baltic Marine Biotope Classification Tool

BSAP – Baltic Sea Action Plan

BSEP – Baltic Sea Environmental Proceedings, HELCOM series

EES – European Environment Agency

EUNIS – European Nature Information System

HD – EU Habitats Directive

HELCOM – Convention of the Protection of the Marine Environment of the Baltic Sea Area

HELCOM HUB – HELCOM Underwater Biotope and habitat classification

JNCC – Joint Nature Conservation Committee, British organization

MSFD – Marine Strategy Framework Directive

MSP – Marine Spatial Planning

OSPAR – Oslo Convention; Convention for the Protection of the Marine Environment of the North-East Atlantic

VELMU – The Finnish Inventory Programme for the Underwater Marine Environment

Definitions

Anthropogenically created substrate = Substrates mainly created through underwater constructions: hard substrate constitutes, e.g. pylons, harbour structures, pipelines whereas soft anthropogenically created substrates constitute, e.g. dumping-sites for dredged materials.

Biomass = The weight of an organism. In the classification, biomass is used as a split rule on Level 6 and any type of biomass can be used: dry-weight, shell-free biomass, wet weight, etc. In the split rule, the weight of all the individuals of a species is intended.

Biotope = The functional unit comprising a specific habitat and community.

Biovolume = Relative volume. In HELCOM HUB, this is a measure applied to plants in the split rule on Level 6; the coverage of the canopy of a species of macrophyte is multiplied by the measured or average height of the species.

Coarse sediment = Grain size analysis definition of coarse sediment is <20% mud/silt/clay fraction (<63 µm) and ≥30% grain size 2–63 mm (Figure 11).

Community = A group of organisms interacting with each other and living in a delineated area, usually at the same time; a community can consist of algae, plants, animals and bacteria.

Coverage = Percentage of an area covered by the measured variable: the percentage estimated from a 1x1 m square area, for example. In the classification, coverage is used to describe substrate and community dominance.

Dominance = Whichever unit/species exhibits the highest value in comparison to the others.

Emergent vegetation = Helophytes and eventual other groups of plants that emerge through the water surface and are attached to the substrate; free-floating vascular plants are not included.

Epifauna = Animals living on the surface of a substrate.

Habitat = Physical environment delineated by specific abiotic environmental factors, such as substrate, salinity, temperature and wave exposure.

Infauna = Animals living burrowed into a substrate.

Macroscopic = Species that can be seen by eye and/or captured when using a sieve according to the guidelines in HELCOM COMBINE Annex C-8 'soft bottom macrozoobenthos'; referring to organisms > 1 mm, in general.

Maërl = Collective term for several species of calcified red algae (e.g. *Phymatolithon calcareum, Lithothamnion glaciale, Lithothamnion corallioides* and *Lithophyllum fasciculatum*) that live unattached on the seafloor.

Marl = Marlrock, a soft type of rock that consists of a mixture of mainly clay and calcium carbonate.

Microvegetation = Plants and algae <1 mm.

Muddy sediment = The grain size analysis definition of muddy sediment is ≥20% mud/silt/clay fraction (<63 µm) (Figure 11).

Peat bottom = Seafloor covered by neofossils; the peat forms as a result of land sinking.

Pelagic = Watermass, can be both off-shore and coastal.

Perennial = A concept that in the classification includes algae, plants and animals that persist in an area for more than one year. In the case of algae and plants, mainly species that serve as habitat for other macroscopic species during the winter months should be considered perennial; i.e., overwintering small plant nodules are not classified as perennial.

Photic zone= The zone above the compensation point (where photosynthesis equals respiration). It can be estimated as being from the water surface down to the depth where 1% of the light available at the surface remains or 2 x Secchi depth. These measures usually correspond to the maximum (potential) depth limit of the vegetated zone.

Rooted = In the classification, this refers to vascular plants with root structures and it also includes Charales, a group of green algae with root-like structures called rhizoids, which anchor the algae to the substrate and thus perform the same major function as the roots of vascular plants.

Sand = Less than 20% of volume is in mud/silt/clay fraction (<63 µm); at least 70% is between 63 µm and 2 mm (Figure 11).

Sessile macroscopic epifauna = Animals larger than 2 mm that are permanently/semi-permanently attached to the substrate surface. Sessile animals also include blue mussels that are attached to a surface but have the potential to move; as a rule, however, they are non-mobile.

Annex 1. Complete list of HUB biotopes

In total, HELCOM HUB identifies 207 benthic biotopes in the photic zone; 115 benthic biotopes in the aphotic zone; 1 sea ice habitat and 5 pelagic habitats; and 10 biotope complexes. This annex lists all the biotopes that have been defined in HELCOM HUB. The listed biotopes can be used as units in further assessments. The **bolded** biotopes represent the lowest Level of the biotope.

In an assessment, the biotope should be classified on Level 5 unless some of the named taxa in a biotope on Level 6 exhibit ≥50% biomass/biovolume dominance. The biotope on Level 5 can be used in an assessment even though biotopes exist under it on Level 6. In these cases, the Level 5 biotope has not been bolded.

The BalMar method was applied to the biological data at a stage when HELCOM HUB biotopes were still being developed and added by expert judgement. Biotopes identified in the data can be seen as verified fixed points in the classification. Biotopes were added after the analysis and some were split into separate groups after the analysis, such as perennial algae and moss that were analysed as one unit but were later split into two separate biotopes. For the Level 6 biotopes, the BalMar method only identified taxa that are dominant, i.e. exhibits ≥50% biomass/biovolume dominance.

Biotope identified a number of times in biological data (number), taxa identified as dominant in data (X), looked for but not identified in data (no),		**All HUB biotopes and habitats, these units can be used in further assessments**
8919 (also moss)	AA.A1C Baltic photic rock and boulders characterised by perennial algae	
		AA.A1C1 Baltic photic rock and boulders dominated by *Fucus* spp.
		AA.A1C2 Baltic photic rock and boulders dominated by perennial non-filamentous corticated red algae
		AA.A1C3 Baltic photic rock and boulders dominated by perennial foliose red algae
		AA.A1C4 Baltic photic rock and boulders dominated by kelp
		AA.A1C5 Baltic photic rock and boulders dominated by perennial filamentous algae
8919 (also perennial algae)	**AA.A1D Baltic photic rock and boulders characterised by aquatic moss**	
	AA.A1E Baltic photic rock and boulders characterised by epibenthic bivalves	
X		**AA.A1E1 Baltic photic rock and boulders dominated by Mytilidae**
		AA.A1E2 Baltic photic rock and boulders dominated by zebra mussel (*Dreissena polymorpha*)
	AA.A1F Baltic photic rock and boulders characterised by epibenthic chordates	
		AA.A1F1 Baltic photic rock and boulders dominated by sea squirts (Ascidiacea)
	AA.A1G Baltic photic rock and boulders characterised by epibenthic cnidarians	
		AA.A1G1 Baltic photic rock and boulders dominated by hydroids (Hydrozoa)
	AA.A1H Baltic photic rock and boulders characterised by epibenthic moss animals (Bryozoa)	
		AA.A1H1 Baltic photic rock and boulders dominated by crustose moss animals (*Electra crustulenta*)
		AA.A1H2 Baltic photic rock and boulders dominated by erect moss animals (*Flustra foliacea*)
	AA.A1I Baltic photic rock and boulders characterised by epibenthic crustacea	
		AA.A1I1 Baltic photic rock and boulders dominated by barnacles (Balanidae)
	AA.A1J Baltic photic rock and boulders characterised by epibenthic sponges (Porifera)	
	AA.A1R Baltic photic rock and boulders characterised by soft crustose algae	

Table continues

2021	**AA.A1S Baltic photic rock and boulders characterised by annual algae**	
	AA.A1V Baltic photic rock and boulders characterised by mixed epibenthic macrocommunity	
X	**AA.A2W Baltic photic rock and boulders characterised by microphytobenthic organisms and grazing snails**	
669	**AA.A2T Baltic photic rock and boulders characterised by sparse epibenthic macrocommunity**	
	AA.A4U Baltic photic rock and boulders characterised by no macrocommunity	
no	AA.B1E Baltic photic hard clay characterised by epibenthic bivalves	
		AA.B1E1 Baltic photic hard clay dominated by Mytilidae
	AA.B1V Baltic photic hard clay characterised by mixed epibenthic macrocommunity	
no	**AA.B2T Baltic photic hard clay characterised by sparse epibenthic macrocommunity**	
2	**AA.B4U Baltic photic hard clay characterised by no macrocommunity**	
	AA.C Baltic photic marl (marlstone rock)	
	AA.D Baltic photic maërl beds	
	AA.E1C Baltic photic shell gravel characterised by perennial algae	
		AA.E1C4 Baltic photic shell gravel dominated by kelp
	AA.E1E Baltic photic shell gravel characterised by epibenthic bivalves	
		AA.E1E1 Baltic photic shell gravel dominated by Mytilidae
	AA.E1F Baltic photic shell gravel characterised by epibenthic chordates	
		AA.E1F1 Baltic photic shell gravel dominated by vase tunicate (*Ciona intestinalis*)
	AA.E1V Baltic photic shell gravel characterised by mixed epibenthic macrocommunity	
	AA.E2T Baltic photic shell gravel characterised by sparse epibenthic macrocommunity	
	AA.E3X Baltic photic shell gravel characterised by mixed infaunal macrocommunity in coarse and well-sorted shells and shell fragments	
	AA.E3Y Baltic photic shell gravel characterised by mixed infaunal macrocommunity in fine sand-like shell fragments	
	AA.E4U Baltic photic shell gravel characterised by no macrocommunity	
no	**AA.F Baltic photic ferromanganese concretion bottom**	
no	**AA.G Baltic photic peat bottoms**	
140	AA.H1A Baltic photic muddy sediment characterised by emergent vegetation	
		AA.H1A1 Baltic photic muddy sediment dominated by common reed (*Phragmites australis*)
		AA.H1A2 Baltic photic muddy sediment dominated by sedges (Cyperaceae)
2337	AA.H1B Baltic photic muddy sediment characterised by submerged rooted plants	
		AA.H1B1 Baltic photic muddy sediment dominated by pondweed (*Potamogeton perfoliatus* and/or *Stuckenia pectinata*)
		AA.H1B2 Baltic photic muddy sediment dominated by *Zannichellia* spp. and/or *Ruppia* spp. and/or *Zostera noltii*
		AA.H1B3 Baltic photic muddy sediment dominated by watermilfoil (*Myriophyllum spicatum* and/or *Myriophyllum sibiricum*)
		AA.H1B4 Baltic photic muddy sediment dominated by Charales
		AA.H1B5 Baltic photic muddy sediment dominated by spiny naiad (*Najas marina*)
		AA.H1B6 Baltic photic muddy sediment dominated by *Ranunculus* spp.
		AA.H1B7 Baltic photic muddy sediment dominated by common eelgrass (*Zostera marina*)
		AA.H1B8 Baltic photic muddy sediment dominated by spikerush (*Eleocharis* spp.)
	AA.H1E Baltic photic muddy sediment characterised by epibenthic bivalves	
X		**AA.H1E1 Baltic photic muddy sediment dominated by Mytilidae**

Table continues

		AA.H1E2 Baltic photic muddy sediment dominated by zebra mussel (*Dreissena polymorpha*)
		AA.H1E3 Baltic photic muddy sediment dominated by valve snails (*Valvata* spp.)
	AA.H1K Baltic photic muddy sediment characterised by epibenthic polychaetes	
		AA.H1K1 Baltic photic muddy sediment dominated by tube building polychaetes
25	AA.H1Q Baltic photic muddy sediment characterised by stable aggregations of unattached perennial vegetation	
		AA.H1Q1 Baltic photic muddy sediment dominated by stable aggregations of unattached *Fucus* spp. (typical form)
		AA.H1Q2 Baltic photic muddy sediment dominated by stable aggregations of unattached *Fucus* spp. (dwarf form)
		AA.H1Q3 Baltic photic muddy sediment dominated by stable aggregations of unattached *Furcellaria lumbricalis*
		AA.H1Q4 Baltic photic muddy sediment dominated by stable aggregations of unattached rigid hornwort (*Ceratophyllum demersum*)
		AA.H1Q5 Baltic photic muddy sediment dominated by stable unattached aggregations of lake ball (*Aegagropila linnaei*)
130	AA.H1S Baltic photic muddy sediment characterised by annual algae	
		AA.H1S3 Baltic photic muddy sediment dominated by *Vaucheria* spp.
	AA.H1V Baltic photic muddy sediment characterised by mixed epibenthic macrocommunity	
	AA.H3L Baltic photic muddy sediment characterised by infaunal bivalves	
X		**AA.H3L1 Baltic photic muddy sediment dominated by Baltic tellin (*Macoma balthica*)**
X		**AA.H3L3 Baltic photic muddy sediment dominated by ocean quahog (*Arctica islandica*)**
		AA.H3L6 Baltic photic muddy sediment dominated by Unionidae
		AA.H3L8 Baltic photic muddy sediment dominated by *Abra* spp.
	AA.H3M Baltic photic muddy sediment characterised by infaunal polychaetes	
		AA.H3M3 Baltic photic muddy sediment dominated by *Marenzelleria* spp.
		AA.H3M5 Baltic photic muddy sediment dominated by various opportunistic polychaetes
	AA.H3N Baltic photic muddy sediment characterised by infaunal crustaceans	
X		**AA.H3N1 Baltic photic muddy sediment dominated by *Monoporeia affinis***
		AA.H3N2 Baltic photic muddy sediment dominated by mud shrimps (Corophiidae)
	AA.H3O Baltic photic muddy sediment characterised by infaunal echinoderms	
	AA.H3P Baltic photic muddy sediment characterised by infaunal insect larvae	
X		**AA.H3P1 Baltic photic muddy sediment dominated by midge larvae (Chironomidae)**
45	AA.H4U Baltic photic muddy sediment characterised by no macrocommunity	
X		**AA.H4U1 Baltic photic muddy sediment dominated by meiofauna (Oligochaeta, Ostracoda, Nematoda)**
no	AA.I1A Baltic photic coarse sediment characterised by emergent vegetation	
		AA.I1A1 Baltic photic coarse sediment dominated by common reed (*Phragmites australis*)
		AA.I1A2 Baltic photic coarse sediment dominated by sedges (Cyperaceae)
189	AA.I1B Baltic photic coarse sediment characterised by submerged rooted plants	
		AA.I1B1 Baltic coarse sediment dominated by pondweed (*Potamogeton perfoliatus* and/or *Stuckenia pectinata*)
		AA.I1B2 Baltic photic coarse sediment dominated by *Zannichellia* spp. and/or *Ruppia* spp. and/or *Zostera noltii*
		AA.I1B4 Baltic photic coarse sediment dominated by Charales
		AA.I1B6 Baltic photic coarse sediment dominated by *Ranunculus* spp.

Table continues

		AA.I1B7 Baltic photic coarse sediment dominated by common eelgrass (*Zostera marina*)
164 (also moss)	AA.I1C Baltic photic coarse sediment characterised by perennial algae	
		AA.I1C1 Baltic photic coarse sediment dominated by *Fucus* spp.
		AA.I1C2 Baltic photic coarse sediment dominated by perennial non-filamentous corticated red algae
		AA.I1C3 Baltic photic coarse sediment dominated by perennial foliose red algae
		AA.I1C4 Baltic photic coarse sediment dominated by kelp
		AA.I1C5 Baltic photic coarse sediment dominated by perennial filamentous algae
164 (also perennial algae)	**AA.I1D Baltic photic coarse sediment characterised by aquatic moss**	
	AA.I1E Baltic photic coarse sediment characterised by epibenthic bivalves	
X		**AA.I1E1 Baltic photic coarse sediment dominated by Mytilidae**
no	AA.I1Q Baltic photic coarse sediment characterised by stable aggregations of unattached perennial vegetation	
		AA.I1Q1 Baltic photic coarse sediment dominated by stable aggregations of unattached *Fucus* spp. (typical form)
		AA.I1Q2 Baltic photic coarse sediment dominated by stable aggregations of unattached *Fucus* spp. (dwarf form)
		AA.I1Q3 Baltic photic coarse sediment dominated by stable aggregations of unattached *Furcellaria lumbricalis*
47	AA.I1S Baltic photic coarse sediment characterised by annual algae	
		AA.I1S2 Baltic photic coarse sediment dominated by *Chorda filum and/or Halosiphon tomentosus*
	AA.I1V Baltic photic coarse sediment characterised by mixed epibenthic macrocommunity	
	AA.I2W Baltic photic coarse sediment characterised by microphytobenthic organisms and grazing snails	
74	**AA.I2T Baltic photic coarse sediment characterised by sparse epibenthic macrocommunity**	
	AA.I3L Baltic photic coarse sediment characterised by infaunal bivalves	
		AA.I3L10 Baltic photic coarse sediment dominated by multiple infaunal bivalve species: *Macoma calcarea, Mya truncata, Astarte spp., Spisula spp.*
		AA.I3L11 Baltic photic coarse sediment dominated by multiple infaunal polychaete species including *Ophelia* spp.
	AA.I3M Baltic photic coarse sediment characterised by infaunal polychaetes	
	AA.I3N Baltic photic coarse sediment characterised by infaunal crustaceans	
		AA.I3N3 Baltic photic coarse sediment dominated by sand digger shrimp (*Bathyporeia pilosa*)
	AA.I3O Baltic photic coarse sediment characterised by infaunal echinoderms	
	AA.I3P Baltic photic coarse sediment characterised by infaunal insect larvae	
8	**AA.I4U Baltic photic coarse sediment characterised by no macrocommunity**	
40	AA.J1A Baltic photic sand characterised by emergent vegetation	
		AA.J1A1 Baltic photic sand dominated by common reed (*Phragmites australis*)
		AA.J1A2 Baltic photic sand dominated by sedges (Cyperaceae)
1670	AA.J1B Baltic photic sand characterised by submerged rooted plants	
		AA.J1B1 Baltic photic sand dominated by pondweed (*Potamogeton perfoliatus* and/or *Stuckenia pectinata*)
		AA.J1B2 Baltic photic sand dominated by *Zannichellia* spp. and/or *Ruppia* spp. and/or *Zostera noltii*
		AA.J1B3 Baltic photic sand dominated by watermilfoil (M*yriophyllum spicatum* and/or *Myriophyllum sibiricum*)
		AA.J1B4 Baltic photic sand dominated by Charales
		AA.J1B5 Baltic photic sand dominated by spiny naiad (*Najas marina*)

Table continues

		AA.J1B6 Baltic photic sand dominated by *Ranunculus* spp.
		AA.J1B7 Baltic photic sand dominated by common eelgrass (*Zostera marina*)
		AA.J1B8 Baltic photic sand dominated by spikerush (*Eleocharis* spp.)
	AA.J1E Baltic photic sand characterised by epibenthic bivalves	
X		**AA.J1E1 Baltic photic sand dominated by Mytilidae**
48	AA.J1Q Baltic photic sand characterised by stable aggregations of unattached perennial vegetation	
		AA.J1Q1 Baltic photic sand dominated by stable aggregations of unattached *Fucus* spp. (typical form)
		AA.J1Q2 Baltic photic sand dominated by stable aggregations of unattached *Fucus* spp. (dwarf form)
		AA.J1Q3 Baltic photic sand dominated by stable aggregations of unattached *Furcellaria lumbricalis*
65	AA.J1S Baltic photic sand characterised by annual algae	
		AA.J1S2 Baltic photic sand dominated by *Chorda filum and/or Halosiphon tomentosus*
		AA.J1S3 Baltic photic sand dominated by *Vaucheria* spp.
	AA.J1V Baltic photic sand characterised by mixed epibenthic macrocommunity	
	AA.J3L Baltic photic sand characterised by infaunal bivalves	
X		**AA.J3L1 Baltic photic sand dominated by Baltic tellin (*Macoma balthica*)**
X		**AA.J3L2 Baltic photic sand dominated by cockles (*Cerastoderma* spp)**
		AA.J3L3 Baltic photic sand dominated by ocean quahog (*Arctica islandica*)
X		**AA.J3L4 Baltic photic sand dominated by sand gaper (*Mya arenaria*)**
		AA.J3L9 Baltic photic sand dominated by multiple infaunal bivalve species: *Cerastoderma spp., Mya arenaria, Astarte borealis, Arctica islandica, Macoma balthica*
		AA.J3L10 Baltic photic sand dominated by multiple infaunal bivalve species: *Macoma calcarea, Mya truncata, Astarte spp., Spisula spp*.
		AA.J3L11 Baltic photic sand dominated by multiple infaunal polychaete species including *Ophelia* spp. and *Travisia forbesii*
	AA.J3M Baltic photic sand characterised by infaunal polychaetes	
		AA.J3M2 Baltic photic sand dominated by lugworms (*Arenicola marina*)
X		**AA.J3M4 Baltic photic sand dominated by multiple infaunal polychaete species: *Pygospio elegans, Marenzelleria spp., Hediste diversicolor***
	AA.J3N Baltic photic sand characterised by infaunal crustaceans	
X		**AA.J3N3 Baltic photic sand dominated by sand digger shrimp (*Bathyporeia pilosa*)**
	AA.J3P Baltic photic sand characterised by infaunal insect larvae	
X		**AA.J3P1 Baltic photic sand dominated by midge larvae (Chironomidae)**
25	**AA.J4U Baltic photic sand characterised by no macrocommunity**	
	AA.K Baltic photic hard anthropogenically created substrates	
	AA.L Baltic photic soft anthropogenically created substrates	
	AA.M1A Baltic photic mixed substrate characterised by emergent vegetation	
		AA.M1A1 Baltic photic mixed substrate dominated by common reed (*Phragmites australis)*
		AA.M1A2 Baltic photic mixed substrate dominated by sedges (Cyperaceae)
1910 (also moss, perennial algae)	AA.M1B Baltic photic mixed substrate characterised by submerged rooted plants	
		AA.M1B1 Baltic photic mixed substrate dominated by pondweed (*Potamogeton perfoliatus* and/or *Stuckenia pectinata*)
		AA.M1B2 Baltic photic mixed substrate dominated by *Zannichellia* spp. and/or *Ruppia* spp. and/or *Zostera noltii*

Table continues

		AA.M1B3 Baltic photic mixed substrate dominated by watermilfoil (*Myriophyllum spicatum* and/or *Myriophyllum sibiricum*)
		AA.M1B4 Baltic photic mixed substrate dominated by Charales
		AA.M1B7 Baltic photic mixed substrate dominated by common eelgrass (*Zostera marina)*
3852 (also moss)	AA.M1C Baltic photic mixed substrate characterised by perennial algae	
		AA.M1C1 Baltic photic mixed substrate dominated by *Fucus* spp.
		AA.M1C2 Baltic photic mixed substrate dominated by perennial non-filamentous corticated red algae
		AA.M1C3 Baltic photic mixed substrate dominated by perennial foliose red algae
		AA.M1C4 Baltic photic mixed substrate dominated by kelp
		AA.M1C5 Baltic photic mixed substrate dominated by perennial filamentous algae
3852 (also perennial algae)	**AA.M1D Baltic photic mixed substrate characterised by aquatic moss**	
	AA.M1E Baltic photic mixed substrate characterised by epibenthic bivalves	
		AA.M1E1 Baltic photic mixed substrate dominated by Mytilidae
		AA.M1E2 Baltic photic mixed substrate dominated by zebra mussel (*Dreissena polymorpha*)
	AA.M1F Baltic photic mixed substrate characterised by epibenthic chordates	
		AA.M1F1 Baltic photic mixed substrate dominated by sea squirts (Ascidiacea)
	AA.M1G Baltic photic mixed substrate characterised by epibenthic cnidarians	
		AA.M1G1 Baltic photic mixed substrate dominated by hydroids (Hydrozoa)
	AA.M1H Baltic photic mixed substrate characterised by epibenthic moss animals (Bryozoa)	
		AA.M1H1 Baltic photic mixed substrate dominated by crustose moss animals (*Electra crustulenta*)
		AA.M1H2 Baltic photic mixed substrate dominated by erect moss animals (*Flustra foliacea*)
	AA.M1I Baltic photic mixed substrate characterised by epibenthic crustacea	
		AA.M1I1 Baltic photic mixed substrate dominated by barnacles (Balanidae)
	AA.M1J Baltic photic mixed substrate characterised by epibenthic sponges (Porifera)	
	AA.M1Q Baltic photic mixed substrate characterised by stable aggregations of unattached perennial vegetation	
		AA.M1Q1 Baltic photic mixed substrate dominated by stable aggregations of unattached *Fucus* spp. (typical form)
		AA.M1Q2 Baltic photic mixed substrate dominated by stable aggregations of unattached *Fucus* spp. (dwarf form)
		AA.M1Q3 Baltic photic mixed substrate dominated by stable aggregations of unattached *Furcellaria lumbricalis*
		AA.M1Q4 Baltic photic mixed substrate dominated by stable aggregations of unattached rigid hornwort (*Ceratophyllum demersum*)
	AA.M1R Baltic photic mixed substrate characterised by soft crustose algae	
518	AA.M1S Baltic photic mixed substrate characterised by annual algae	
		AA.M1S1 Baltic photic mixed substrate dominated by filamentous annual algae
		AA.M1S2 Baltic photic mixed substrate dominated by *Chorda filum* and/or *Halosiphon tomentosus*
	AA.M1V Baltic photic mixed substrate characterised by mixed epibenthic macrocommunity	
	AA.M2W Baltic photic mixed substrate characterised by microphytobenthic organisms and grazing snails	
940	**AA.M2T Baltic photic mixed substrate characterised by sparse epibenthic macrocommunity**	
	AA.M4U Baltic photic mixed substrate characterised by no macrocommunity	

	AB.A1E Baltic aphotic rock and boulders characterised by epibenthic bivalves	

Table continues

		AB.A1E1 Baltic aphotic rock and boulder dominated by Mytilidae
	AB.A1F Baltic aphotic rock and boulders characterised by epibenthic chordates	
		AB.A1F1 Baltic aphotic rock and boulders dominated by sea squirts (Ascidiacea)
	AB.A1G Baltic aphotic rock and boulders characterised by epibenthic cnidarians	
		AB.A1G1 Baltic aphotic rock and boulders dominated by hydroids (Hydrozoa)
		AB.A1G2 Baltic aphotic rock and boulders dominated by sea anemones (Actiniarida)
		AB.A1G3 Baltic aphotic rock and boulders dominated stone corals (Scleractinida)
		AB.A1G4 Baltic aphotic rock and boulders dominated by soft corals (Alcyonacea)
	AB.A1H Baltic aphotic rock and boulders characterised by epibenthic moss animals (Bryozoa)	
		AB.A1H1 Baltic aphotic rock and boulders dominated by corticated moss animals (*Electra crustulenta*)
		AB.A1H2 Baltic aphotic rock and boulders dominated by erect moss animals (*Flustra foliacea)*
	AB.A1I Baltic aphotic rock and boulders characterised by epibenthic crustacea	
		AB.A1I1 Baltic aphotic rock and boulders dominated by barnacles (Balanidae)
	AB.A1J Baltic aphotic rock and boulders characterised by epibenthic sponges (Porifera)	
	AB.A1V Baltic aphotic rock and boulder characterised by mixed epibenthic macrocommunity	
no	**AB.A2T Baltic aphotic rock and boulders characterised by sparse epibenthic macrocommunity**	
	AB.A4U Baltic aphotic rock and boulders characterised by no macrocommunity	
no	AB.B1E Baltic aphotic hard clay characterised by epibenthic bivalves	
		AB.B1E1 Baltic aphotic hard clay dominated by Mytilidae
		AB.B1E4 Baltic aphotic hard clay dominated by *Astarte* spp.
	AB.B1V Baltic aphotic hard clay characterised by mixed epibenthic macrocommunity	
no	**AB.B2T Baltic aphotic hard clay characterised by sparse epibenthic macrocommunity**	
no	**AB.B4U Baltic aphotic hard clay characterised by no macrocommunity**	
	AB.C Baltic aphotic marl (marlstone rock)	
	AB.D Baltic aphotic maërl beds	
	AB.E1E Baltic aphotic shell gravel characterised by epibenthic bivalves	
X		**AB.E1E1 Baltic aphotic shell gravel dominated by Mytilidae**
	AB.E1F Baltic aphotic shell gravel characterised by epibenthic chordates	
		AB.E1F1 Baltic aphotic shell gravel dominated by vase tunicate (*Ciona intestinalis*)
	AB.E1V Baltic aphotic shell gravel characterised by mixed epibenthic macrocommunity	
	AB.E2T Baltic aphotic shell gravel characterised by sparse epibenthic macrocommunity	
	AB.E3X Baltic aphotic shell gravel characterised by mixed infaunal macrocommunity in coarse and well-sorted shells and shell fragments	
	AB.E3Y Baltic aphotic shell gravel characterised by mixed infaunal macrocommunity in fine sand-like shell fragments	
	AB.E4U Baltic aphotic shell gravel characterised by no macrocommunity	
	AB.F Baltic aphotic ferromanganese concretion bottom	
	AB.G Baltic aphotic peat bottoms	
	AB.H1E Baltic aphotic muddy sediment characterised by epibenthic bivalves	
		AB.H1E1 Baltic aphotic muddy sediment dominated by Mytilidae
	AB.H1G Baltic aphotic muddy sediment characterised by epibenthic cnidarians	
	AB.H1I Baltic aphotic muddy sediment characterised by epibenthic crustacea	

Table continues

		AB.H1I2 Baltic aphotic muddy sediment dominated by *Haploops* spp.
	AB.H1K Baltic aphotic muddy sediment characterised by epibenthic polychaetes	
		AB.H1K1 Baltic aphotic muddy sediment dominated by tube-building polychaetes
	AB.H1V Baltic aphotic muddy sediment characterised by mixed epibenthic macrocommunity	
52	AB.H2T Baltic aphotic muddy sediment characterised by sparse epibenthic macrocommunity	
		AB.H2T1 Baltic aphotic muddy sediment dominated by seapens
	AB.H3L Baltic aphotic muddy sediment characterised by infaunal bivalves	
X		**AB.H3L1 Baltic aphotic muddy sediment dominated by Baltic tellin (*Macoma baltica*)**
		AB.H3L3 Baltic aphotic muddy sediment dominated by ocean quahog (*Arctica islandica*)
		AB.H3L5 Baltic aphotic muddy sediment dominated by *Astarte* spp.
	AB.H3M Baltic aphotic muddy sediment characterised by infaunal polychaetes	
		AB.H3M1 Baltic aphotic muddy sediment dominated by *Scoloplos (Scoloplos) armiger*
X		**AB.H3M3 Baltic aphotic muddy sediment dominated by *Marenzelleria* spp.**
		AB.H3M5 Baltic aphotic muddy sediment dominated by various opportunistic polychaetes
	AB.H3N Baltic aphotic muddy sediment characterised by infaunal crustaceans	
X		**AB.H3N1 Baltic aphotic muddy sediment dominated by *Monoporeia affinis* and/or *Pontoporeia femorata***
	AB.H3O Baltic aphotic muddy sediment characterised by infaunal echinoderms	
		AB.H3O1 Baltic aphotic muddy sediment dominated by *Amphiura filiformis*
		AB.H3O2 Baltic aphotic muddy sediment dominated by *Brissopsis lyrifera* and *Amphiura chiajei*
	AB.H3P Baltic aphotic muddy sediment characterised by infaunal insect larvae	
X		**AB.H3P1 Baltic aphotic muddy sediment dominated by midge larvae (Chironomidae)**
X	AB.H4U Baltic aphotic muddy sediment characterised by no macrocommunity	
		AB.H4U1 Baltic aphotic muddy sediment dominated by meiofauna
		AB.H4U2 Baltic aphotic muddy sediment dominated by anaerobic organisms
	AB.I1E Baltic aphotic coarse sediment characterised by epibenthic bivalves	
X		**AB.I1E1 Baltic aphotic coarse sediment dominated by Mytilidae**
	AB.I1V Baltic aphotic coarse sediment characterised by mixed epibenthic macrocommunity	
	AB.I3L Baltic aphotic coarse sediment characterised by infaunal bivalves	
		AB.I3L10 Baltic aphotic coarse sediment dominated by multiple infaunal bivalve species: *Macoma calcarea, Mya truncata, Astarte spp., Spisula spp.*
		AB.I3L11 Baltic aphotic coarse sediment dominated by multiple infaunal polychaet-species including *Ophelia* spp.
	AB.I3M Baltic aphotic coarse sediment characterised by infaunal polychaetes	
	AB.I3N Baltic aphotic coarse sediment characterised by infaunal crustaceans	
		AB.I3N3 Baltic aphotic coarse sediment dominated by sand digger shrimp (*Bathyporeia pilosa*)
25	AB.I4U Baltic aphotic coarse sediment chracterized by no macrocommunity	
		AB.I4U1 Baltic aphotic coarse sediment dominated by meiofauna
	AB.J1E Baltic aphotic sand characterised by epibenthic bivalves	
X		**AB.J1E1 Baltic aphotic sand dominated by unattached Mytilidae**
	AB.J1V Baltic aphotic sand characterised by mixed epibenthic macroscopic community	
	AB.J3L Baltic aphotic sand characterised by infaunal bivalves	

Table continues

X		**AB.J3L1 Baltic aphotic sand dominated by Baltic tellin (*Macoma balthica*)**
		AB.J3L3 Baltic aphotic sand dominated by ocean quahog (*Arctica islandica*)
X		**AB.J3L4 Baltic aphotic sand dominated by sand gaper (*Mya arenaria*)**
		AB.J3L7 Baltic aphotic sand dominated by striped venus (*Chamelea gallina*)
X		**AB.J3L9 Baltic aphotic sand dominated by multiple infaunal bivalve species: *Cerastoderma spp., Mya arenaria, Astarte borealis, Arctica islandica, Macoma balthica***
		AB.J3L10 Baltic aphotic sand dominated by multiple infaunal bivalve species: *Macoma calcarea, Mya truncata, Astarte spp., Spisula spp.*
		AB.J3L11 Baltic aphotic sand dominated by multiple infaunal polychaete species including *Ophelia* spp. and *Travisia forbesii*
	AB.J3M Baltic aphotic sand characterised by infaunal polychaetes	
X		**AB.J3M4 Baltic aphotic sand dominated by multiple infaunal polychaete species: *Pygospio elegans, Marenzelleria spp., Hediste diversicolor***
	AB.J3N Baltic aphotic sand characterised by infaunal crustacea	
X		**AB.J3N1 Baltic aphotic sand dominated by *Monoporeia affinis* and *Saduria entomon***
	AB.J3P Baltic aphotic sand characterised by infaunal insect larvae	
X		**AB.J3P1 Baltic aphotic sand dominated by midge larvae (Chironomidae)**
30	AB.J4U Baltic aphotic sand characterised by no macrocommunity	
X		**AB.J4U1 Baltic aphotic sand dominated by meiofauna**
	AB.K Baltic aphotic hard anthropogenically created substrates	
	AB.L Baltic aphotic soft anthropogenically created substrates	
	AB.M1E Baltic aphotic mixed substrate characterised by epibenthic bivalves	
X		**AB.M1E1 Baltic aphotic mixed substrate dominated by Mytilidae**
	AB.M1F Baltic aphotic mixed substrate characterised by epibenthic chordates	
		AB.M1F1 Baltic aphotic mixed substrate dominated by sea squirts (Ascidiacea)
	AB.M1G Baltic aphotic mixed substrate characterised by epibenthic cnidarians	
		AB.M1G1 Baltic aphotic mixed substrate dominated by hydroids (Hydrozoa)
		AB.M1G2 Baltic aphotic mixed substrate dominated by sea anemones (Actiniarida)
		AB.M1G3 Baltic aphotic mixed substrate dominated stone corals (Scleractinida)
		AB.M1G4 Baltic aphotic mixed substrate dominated by soft corals (Alcyonacea)
	AB.M1H Baltic aphotic mixed substrate characterised by epibenthic moss animals (Bryozoa)	
		AB.M1H1 Baltic aphotic mixed substrate dominated by corticated moss animals (*Electra crustulenta*)
		AB.M1H2 Baltic aphotic mixed substrate dominated by erect moss animals (*Flustra foliacea*)
	AB.M1I Baltic aphotic mixed substrate characterised by epibenthic crustacea	
		AB.M1I1 Baltic aphotic mixed substrate dominated by barnacles (Balanidae)
	AB.M1J Baltic aphotic mixed substrate characterised by epibenthic sponges (Porifera)	
	AB.M1V Baltic aphotic mixed substrate characterised by mixed epibenthic macrocommunity	
no	**AB.M2T Baltic aphotic mixed substrate characterised by sparse epibenthic macrocommunity**	
	AB.M4U Baltic aphotic mixed substrate characterised by no macrocommunity	
	AC Baltic Sea Seasonal Ice	
	AD.N5 Baltic Sea Photic Pelagic above halocline oxic	
	AE.N5 Baltic Sea Aphotic Pelagic above halocline oxic	

Table continues

	AE.N6 Baltic Sea Aphotic Pelagic above halocline anoxic
	AE.O5 Baltic Sea Aphotic Pelagic below halocline oxic
	AE.O6 Baltic Sea Aphotic Pelagic below halocline anoxic

HUB Biotope Complexes (Habitats Directive Annex 1 habitats, EUR27)
1110 Sandbanks which are slightly covered by sea water all the time
1130 Estuaries
1140 Mudflats and sandflats not covered by seawater at low tide
1150 Coastal lagoons
1160 Large shallow inlets and bays
1170 Reefs
1180 Submarine structures made by leaking gas
1610 Baltic esker islands with sandy, rocky and shingle beach vegetation and sublittoral vegetation
1620 Boreal Baltic islets and small islands
1650 Boreal Baltic narrow inlets

Annex 2. Comparison of HELCOM HUB biotopes and the previous HELCOM habitat classification

In comparison with the previous HELCOM classification system, it is quite clear that HELCOM HUB has integrated more biological information and created a system that classifies biotopes to a more detailed level.

In the previous HELCOM classification, biotopes were delineated mainly based on substrates and macrophyte vegetation. In HELCOM HUB, macrophytes and animals have been assigned equal weight in the split on Levels 4 and 5.

The definition of biotope is more strictly defined in HELCOM HUB, meaning that biotopes in the previous classifications can be referred to as habitats in HELCOM HUB.

HELCOM 1998	Closest corresponding HELCOM HUB biotope	Level in HELCOM HUB
1. Pelagic marine biotopes		
1.1 Offshore (deep) waters	AD Baltic Sea Photic Pelagic AE Baltic Sea Aphotic Pelagic	2
1.1.1 Above the halocline	AD.N Baltic Sea Photic Pelagic above halocline AE.N Baltic Sea Aphotic Pelagic above halocline	3
1.1.2 Below the halocline	AE.O Baltic Sea Aphotic Pelagic below halocline	3
1.2 Coastal (shallow) waters		
1.2.1 Outer		
1.2.2 Inner		
2. Benthic marine biotopes		
2.1 Rocky bottoms		
2.1.1 Soft rock		
2.1.1.1 Aphotic zone	AB.C Baltic aphotic marl (marlstone rock)	3
2.1.1.2 Sublittoral photic zone	AA.C Baltic photic marl (marlstone rock)	3
2.1.1.2.1 Level bottoms with little or no macrophyte vegetation		
2.1.1.2.2 Level bottoms dominated by macrophyte vegetation		
2.1.1.2.3 Reefs		
2.1.1.3 Hydrolittoral		
2.1.1.3.1 Level bottoms with little or no macrophyte vegetation		
2.1.1.3.2 Level bottoms dominated by macrophyte vegetation		
2.1.1.3.3 Reefs		
2.1.2 Solid rock (bedrock)	AA.A Baltic photic rock and boulders AB.A Baltic aphotic rock and boulders	3
2.1.2.1 Photic zone		
2.1.2.2 Sublittoral photic zone		
2.1.2.2.1 Level bottoms with little or no macrophyte vegetation	AA.A2T Baltic photic rock and boulders characterised by sparse epibenthic macrocommunity	5
2.1.2.2.2 Level bottoms dominated by macrophyte vegetation	AA.A1C Baltic photic rock and boulders characterised by perennial algae AA.A1D Baltic photic rock and boulders characterised by aquatic moss	5
2.1.2.2.3 Reefs		
2.1.2.3 Hydrolittoral		
2.1.2.3.1 Level bottoms with little or no macrophyte vegetation	AA.A2T Baltic photic rock and boulders characterised by sparse epibenthic macrocommunity	5
2.1.2.3.2 Level bottoms dominated by macrophyte vegetation	AA.A1C Baltic photic rock and boulders characterised by perennial algae AA.A1D Baltic photic rock and boulders characterised by aquatic moss	5
2.1.2.3.3 Reefs		

Table continues

2.2 Stony bottoms	AA.A Baltic photic rock and boulders AB.A Baltic aphotic rock and boulders	3
2.2.1 Aphotic zone		
2.2.2 Sublittoral photic zone		
2.2.2.1 Level bottoms with little or no macrophyte vegetation	AA.A2T Baltic photic rock and boulders characterised by sparse epibenthic macrocommunity AA.A4U Baltic photic rock and boulders characterised by no macrocommunity	5
2.2.2.2 Level bottoms dominated by macrophyte vegetation	AA.A1C Baltic photic rock and boulders characterised by perennial algae AA.A1D Baltic photic rock and boulders characterised by aquatic moss AA.A1R Baltic photic rock and boulders characterised by soft crustose algae AA.A1S Baltic photic rock and boulders characterised by annual algae	5
2.2.2.3 Reefs		
2.2.3 Hydrolittoral		
2.2.3.1 Level bottoms with little or no macrophyte vegetation	AA.A2T Baltic photic rock and boulders characterised by sparse epibenthic macrocommunity AA.A4U Baltic photic rock and boulders characterised by no macrocommunity	5
2.2.3.2 Level bottoms dominated by macrophyte vegetation	AA.A1C Baltic photic rock and boulders characterised by perennial algae AA.A1D Baltic photic rock and boulders characterised by aquatic moss AA.A1R Baltic photic rock and boulders characterised by soft crustose algae AA.A1S Baltic photic rock and boulders characterised by annual algae	5
2.2.3.3 Reefs		
2.3 Hard clay bottoms		
2.3.1 Aphotic zone	AB.B Baltic aphotic hard clay	3
2.3.2 Sublittoral photic zone	AA.B Baltic photic hard clay	3
2.3.2.1 Bottoms with little or no macrophyte vegetation	AA.B2T Baltic photic hard clay characterised by sparse epibenthic macrocommunity AA.B4U Baltic photic hard clay characterised by no macrocommunity	5
2.3.3 Hydrolittoral		
2.3.3.1 Bottoms with little or no macrophyte vegetation	AA.B2T Baltic photic hard clay characterised by sparse epibenthic macrocommunity AA.B4U Baltic photic hard clay characterised by no macrocommunity	5
2.4 Gravel bottoms		
2.4.1 Aphotic zone	AB.I Baltic aphotic coarse sediment	3
2.4.2 Sublittoral photic zone	AA.I Baltic photic coarse sediment	3
2.4.2.1 Level bottoms with little or no macrophyte vegetation	AA.I2T Baltic photic coarse sediment characterised by sparse epibenthic macrocommunity AA.I4U Baltic photic coarse sediment characterised by no macrocommunity	5
2.4.2.2 Level bottoms dominated by macrophyte vegetation	AA.I1A Baltic photic coarse sediment characterised by emergent vegetation AA.I1B Baltic photic coarse sediment characterised by submerged rooted plants AA.I1C Baltic photic coarse sediment characterised by perennial algae AA.I1D Baltic photic coarse sediment characterised by aquatic moss AA.I1Q Baltic photic coarse sediment characterised by stable aggregations of unattached perennial vegetation AA.I1S Baltic photic coarse sediment characterised by annual algae	5
2.4.2.3 Banks with or without macrophyte vegetation		

Table continues

2.4.3 Hydrolittoral		
2.4.3.1 Level bottoms with little or no macrophyte vegetation	AA.I2T Baltic photic coarse sediment characterised by sparse epibenthic macrocommunity AA.I4U Baltic photic coarse sediment characterised by no macrocommunity	5
2.4.3.2 Level bottoms dominated by macrophyte vegetation	AA.I1A Baltic photic coarse sediment characterised by emergent vegetation AA.I1B Baltic photic coarse sediment characterised by submerged rooted plants AA.I1C Baltic photic coarse sediment characterised by perennial algae AA.I1D Baltic photic coarse sediment characterised by aquatic moss AA.I1Q Baltic photic coarse sediment characterised by stable aggregations of unattached perennial vegetation AA.I1S Baltic photic coarse sediment characterised by annual algae	5
2.4.3.3 Banks with or without macrophyte vegetation		
2.5 Sandy bottoms		
2.5.1 Aphotic zone	AB.J Baltic aphotic sand	3
2.5.2 Sublittoral photic zone	AA.J Baltic photic sand	3
2.5.2.1 Level bottoms with little or no macrophyte vegetation	AA.J4U Baltic photic sand characterised by no macrocommunity	5
2.5.2.2 Level bottoms dominated by macrophyte vegetation	AA.J1A Baltic photic sand characterised by emergent vegetation AA.J1B Baltic photic sand characterised by submerged rooted plants AA.J1Q Baltic photic sand characterised by stable aggregations of unattached perennial vegetation AA.J1S Baltic photic sand characterised by annual algae	5
2.5.2.3 Bars		
2.5.2.4 Banks with or without macrophyte vegetation		
2.5.3 Hydrolittoral		
2.5.3.1 Level bottoms with little or no macrophyte vegetation	AA.J4U Baltic photic sand characterised by no macrocommunity	5
2.5.3.2 Level bottoms dominated by macrophyte vegetation	AA.J1A Baltic photic sand characterised by emergent vegetation AA.J1B Baltic photic sand characterised by submerged rooted plants AA.J1Q Baltic photic sand characterised by stable aggregations of unattached perennial vegetation AA.J1S Baltic photic sand characterised by annual algae	5
2.5.3.3 Bars		
2.5.3.4 Banks with or without macrophyte vegetation		
2.6 Shell gravel bottoms		
2.6.1 Aphotic zone	AB.E Baltic aphotic shell gravel	3
2.6.2 Sublittoral photic zone	AA.E Baltic photic shell gravel	3
2.7 Muddy bottoms		
2.7.1 Aphotic zone	AB.H Baltic aphotic muddy sediment	3
2.7.2 Sublittoral photic zone	AA.H Baltic photic muddy sediment	3
2.7.2.1 With little or no macrophyte vegetation	AA.H4U Baltic photic muddy sediment characterised by no macrocommunity	5
2.7.2.2 Dominated by macrophyte vegetation	AA.H1A Baltic photic muddy sediment characterised by emergent vegetation AA.H1B Baltic photic muddy sediment characterised by submerged rooted plants AA.H1Q Baltic photic muddy sediment characterised by stable aggregations of unattached perennial vegetation AA.H1S Baltic photic muddy sediment characterised by annual algae	5
2.7.3 Hydrolittoral		
2.7.3.1 With little or no macrophyte vegetation	AA.H4U Baltic photic muddy sediment characterised by no macrocommunity	5

Table continues

2.7.3.2 Dominated by macrophyte vegetation	AA.H1A Baltic photic muddy sediment characterised by emergent vegetation AA.H1B Baltic photic muddy sediment characterised by submerged rooted plants AA.H1Q Baltic photic muddy sediment characterised by stable aggregations of unattached perennial vegetation AA.H1S Baltic photic muddy sediment characterised by annual algae	5
2.8 Mixed sediment bottoms		
2.8.1 Aphotic zone	AB.M Baltic aphotic mixed substrate	3
2.8.2 Sublittoral photic zone	AA.M Baltic photic mixed substrate	3
2.8.2.1 With little or no macrophyte vegetation	AA.M2T Baltic photic mixed substrate characterised by sparse epibenthic macrocommunity AA.M4U Baltic photic mixed substrate characterised by no macrocommunity	5
2.8.2.2 Dominated by macrophyte vegetation	AA.M1A Baltic photic mixed substrate characterised by emergent vegetation AA.M1B Baltic photic mixed substrate characterised by submerged rooted plants AA.M1C Baltic photic mixed substrate characterised by perennial algae AA.M1D Baltic photic mixed substrate characterised by aquatic moss	5
2.8.3 Hydrolittoral		
2.8.3.1 With little or no macrophyte vegetation	AA.M2T Baltic photic mixed substrate characterised by sparse epibenthic macrocommunity AA.M4U Baltic photic mixed substrate characterised by no macrocommunity	5
2.8.3.2 Dominated by macrophyte vegetation	AA.M1A Baltic photic mixed substrate characterised by emergent vegetation AA.M1B Baltic photic mixed substrate characterised by submerged rooted plants AA.M1C Baltic photic mixed substrate characterised by perennial algae AA.M1D Baltic photic mixed substrate characterised by aquatic moss	5
2.9 Mussel beds		
2.9.1 Aphotic zone	AB.A1E Baltic aphotic rock and boulders characterised by epibenthic bivalves	5
2.9.2 Sublittoral photic zone	AA.A1E Baltic photic rock and boulders characterised by epibenthic bivalves	5
2.9.2.1 With little or no macrophyte vegetation		
2.9.2.2 Dominated by macrophyte vegetation		
2.9.3 Hydrolittoral		
2.9.3.1 With little or no macrophyte vegetation		
2.9.3.2 Dominated by macrophyte vegetation		
2.10 Bubbling reefs	1180 Submarine structures made by leaking gas	Biotope complex
2.10.1 Aphotic zone		
2.10.2 Sublittoral photic zone		
2.10.2.1 With little or no macrophyte vegetation		
2.10.2.2 Dominated by macrophyte vegetation		
2.11 Peat bottoms	AA.G Baltic photic peat bottoms AB.G Baltic aphotic peat bottoms	3
2.11.1 Sublittoral		
2.11.2 Hydrolittoral		

Annex 3. Height tables for vegetation

When classifying biotopes dominated by macrophytes down to Level 6, information on biovolume is needed. Height information should be collected during the sampling. If no such data are available, local height estimates described in the literature for the species should be considered.

The average height for some species varies significantly depending on the place where they grow; for example, *Fucus vesiculosus* is known to grow much higher in sheltered bays than on exposed shorelines. Expert judgement is needed when determining whether to use the average minimum or the average maximum value.

The following table presents measured heights of selected species along the Finnish coast. The values should only be used as a last resort when classifying biotopes on Level 6 if no other height information is available.

Macrophyte species	Min [cm]	Max [cm]
Acrosiphonia arcta	3	5
Aglaothamnion roseum	3	4
Audouinella spp.	0.3	2
Batrachospermum spp.	3	3
Callitriche hermafroditica	0.3	35
Ceramium tenuicorne	0.5	40
Ceramium virgatum	4	4
Ceratophyllum demersum	5	50
Chara aspera	3	50
Chara baltica	3	10
Chara braunii	10	10
Chara canescens	10	10
Chara connivens	8	8
Chara globularis	5	15
Chara horrida	20	50
Chara tomentosa	4	30
Chorda filum	2	60
Cladophora aegagropila	0.5	5
Cladophora fracta	5	10
Cladophora glomerata	0.3	20
Cladophora rupestris	1	10
Coccotylus truncatus	1	5
Dictyosiphon chordaria	5	20
Dictyosiphon foeniculaceus	3	50
Ectocarpus siliculosus	0.5	50
Elachista fucicola	0.05	3
Elatine hydropiper	0.3	5
Eleocharis acicularis	2	5
Elodea canadensis	10	40
Eudesme virescens	5	50
Fissidens adianthoides	0	0
Fissidens fontanus	1	10
Fontinalis antipyretica	1	30

Macrophyte species	Min [cm]	Max [cm]
Fontinalis dalecarlica	20	30
Fontinalis hypnoides	3	15
Fucus radicans	3	35
Fucus vesiculosus	1	50
Furcellaria lumbricalis	0.1	15
Hildenbrandia rubra	0.1	0.1
Isoetes echinospora	4	4
Lemna trisulca	0.1	0.2
Limosella aquatica	2	2
Monostroma grevillei	2	10
Myriophyllum alterniflorum	5	100
Myriophyllum sibiricum	10	60
Myriophyllum spicatum	5	150
Myriophyllum verticillatum	5	80
Najas marina	0.9	270
Nitella flexilis	4	35
Oscillatoria spp	0.5	1
Phragmites australis	15	250
Phyllophora pseudoceranoides	3	10
Pilayella littoralis	0.1	20
Polysiphonia fibrillosa	2	50
Polysiphonia fucoides	0.1	12.5
Potamogeton filiformis	0.2	30
Potamogeton gramineus	10	90
Potamogeton pectinatus	1.5	150
Potamogeton perfoliatus	1.5	400
Potamogeton praelongus	12	22
Potamogeton pusillus	10	45
Pseudolithoderma spp.	0.1	0.1
Ranunculus baudotii	5	250
Ranunculus circinatus	1	25
Ranunculus confervoides	2	50
Rhizoclonium riparium	1	2

Macrophyte species	**Min [cm]**	**Max [cm]**
Rhodocorton spp.	0.3	0.5
Rhodomela confervoides	0.1	8
Rhodophyta	3	15
Rhynchostegium riparioides	5	5
Rivularia spp.	0.1	3
Ruppia cirrhosa	1	20
Ruppia maritima	10	30
Sagittaria natans	5	40
Schoenoplectus lacustris	11	100
Schoenoplectus tabernaemontani	70	70
Scirpus spp.	80	80
Scytosiphon lomentaria	5	5
Sphacelaria arctica	0.1	10
Spirogyra spp.	3	20
Spirulina spp.	0.1	0.2
Stictyosiphon tortilis	3	60
Subularia aquatica	2	3
Tolypella nidifica	3	20
Tolypothrix spp.	1	1
Ulothrix zonata	1	10
Ulva intestinalis	1	30
Vaucheria spp.	1	20
Zannichellia major	1	30
Zannichellia palustris	3	100
Zannichellia pedicellata	15	20
Zannichellia repens	15	35
Zostera marina	12	60

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