

HIERARCHICAL SYSTEM FOR CLASSIFICATION OF BALTIC MARINE BIOTOPES

-criteria and definitions

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BASIS

The classification system is based on physical environment and plant and animal communities. So far the classification includes only examples from phytobenthos, where the classification is based on visually observed macrophytes and sessile epifauna (mussels, barnacles, polyps etc.). Classification of pelagic water column or seafloor infaunal communities is yet to be created.

TERMINOLOGY

Phytobenthic Zone, Phytobenthos

The phytobenthic zone is defined as the plant and animal communities of the photic zone, also including the animals on hard substrates (e.g., blue mussels) below the photic zone at depths less than 25 meters (TemaNord 1996). The bottom-living plant and animal communities in the phytobenthic zone together form the phytobenthos.

Habitat, Community, and Biotope

A *community* is defined as a "group of organisms occurring in a particular environment, presumably interacting with each other and with the environment, and separable by means of ecological survey from other groups" (Mills 1969). The physical environment in which the community and species are living is called a *habitat*. The habitat and its associated community are together referred to as a *biotope*.

Scale, coverage and visual abundance

The *area* covered by a biotope can range from ca. 20 to 100 m² or more. *Coverage* is the visually estimated coverage per cent of a given substrate or species. A *visual abundance* is an index, where the average height of the plants or epifauna is also taken into account. Multiplying the coverage values by the average height values results in an index that describes the "visual abundance" or "visual volume" of a given species or group. Visual abundance is used as a measure for dominance of a species or group at levels 7-9.

Hierarchical levels

Five different levels of abiotic elements and three levels of biological elements were distinguished in the classification. The abiotic levels are:

1. Main habitat
2. Salinity
3. Zone
4. Substrate
5. Mechanical ice-influence
6. Wave exposure

The biological levels are:

1. Functional group
2. Species level 1
3. Species level 2

Each level contains several different classes. The different classes and their criteria at each level are following:

LEVEL 1. MARINE HABITATS

Main habitat	Definition
Marine	Of, or connected with, the sea (the continuous body of water covering most of the earth's surface and surrounding its land masses). Marine waters may be fully saline, brackish or almost fresh.
Sub-classes	
Pelagic	The open-water column, as distinct from the bed or shore, inhabited by swimming and drifting marine or freshwater organisms
Sea bed	The floor of the sea or the ocean

LEVEL 2 . SALINITY

Class	Salinity (per mils)
Very low	<2
Low	2-4
Medium	4-8
High	8-16
Very high	>16

LEVEL 3. ZONE

Zone	Definition
Hydrolittoral	Zone between the highest and lowest water level
Sublittoral photic	Zone of primary production below the lowest water level
Sublittoral aphotic	Zone below sublittoral photic zone

LEVEL 4. SUBSTRATE.

Substrates are divided into three main classes and several sub-classes. Sub-classes may be added when more data from different parts of the Baltic Sea is obtained.

Main substrate	Definition
Non-mobile rock and other hard substrata	Coverage of non-mobile rock and other hard substrata at least 90 %
SUB-TYPES:	
Bedrock	Coverage of bedrock at least 90%
Limestone rock	Coverage of limestone rock at least 90%
Boulders	Coverage of boulders at least 90%
Stones	Coverage of non-mobile stones at least 90%
Hard clay	Coverage of hard clay at least 90%
Limestones	Coverage of non-mobile limestones at least 90%
Mixture of non-mobile substrates	Coverage of mixtures of non-mobile substrates at least 90 %. Mixture can be any combination of non-mobile substrates like

	bedrock and stones, boulders and tones etc.
Main type:	
Mobile sediments	Coverage of mobile sediments at least 90%
Sub-types:	
Mobile stones	Coverage of mobile stones at least 90%
Pebbles	Coverage of pebble at least 90%
Gravel	Coverage of gravel at least 90%
Sand	Coverage of sand at least 90%
Fine sand	Coverage of fine sand at least 90%
Mud	Coverage of mud at least 90%
Shell gravel	Coverage of shell gravel at least 90%
Bubbling reefs	Coverage of bubbling reefs at least 90%
Peat bottom	Coverage of peat bottom at least 90%
Mixture of mobile sediments	Coverage of mixture mobile sediments at least 90%. Mixture can be any combination of mobile sediments like sand and gravel, gravel and shell gravel etc.
Main class:	
Mixture of non-mobile and mobile substrates	Coverage of non-mobile rock and other hard substrata 10-90% and coverage of mobile substrata 10-90%. The mixture can be any combination of non-mobile rock and other hard substrata and mobile sediments
Sub-types (examples):	
Boulders and sand	Coverage of boulders 10-90% and coverage of sand 10-90%.
Bedrock and sand	Coverage of bedrock 10-90% and coverage of sand 10-90%.

Definition of the particle size of different substrates:

Substrate	Particle size
Hard clay	<0.002 mm
Mud	<0.06 mm
Fine sand	0.06-0.1 mm
Sand	0.1-2 mm
Gravel	2-20 mm
Pebbles and mobile stones	20-100 mm or bigger on very exposed sites
Non-mobile stones	100-1000 mm or smaller on very sheltered sites
Boulders	>1000 mm

LEVEL 5. MECHANICAL ICE INFLUENCE

Mechanical ice influence (ice-scraping) may be caused by solid ice on shallow areas, where the water column freezes to the bottom or by moving packed ice. On certain areas in the Bothnian Bay and Gulf of Finland packed ice walls can cause ice-scraping down to 20-30 metres deep.

Class	Definition
Non-mobile rock and other hard substrata influenced by ice-scraping	Non-mobile rock and other hard substrata, which are normally influenced by ice-scraping during the winter
Non-mobile rock and other hard substrata not influenced by ice-scraping	Non-mobile rock and other hard substrata, which are normally not influenced by ice-scraping during the winter
Mobile sediments influenced by ice-scraping	Mobile sediments, which are normally influenced by ice-scraping during the winter
Mobile sediments not influenced by ice-scraping	Mobile sediments, which are normally not influenced by ice-scraping during the winter
Mixture of mobile and non-mobile substrates influenced by ice-scraping	Mixture of mobile and non-mobile substrates which are normally influenced by ice-scraping during the winter
Mixture of mobile and non-mobile substrates not influenced by ice-scraping	Mixture of mobile and non-mobile substrates which are normally not influenced by ice-scraping during the winter

LEVEL 6. WAVE EXPOSURE

Wave exposure is estimated according to the *effective fetch* (L_i) (Håkansson (1981) with following modifications:

1. Instead of to the nearest shore, the fetch lines are calculated to the nearest 1-meter depth contour.
2. If the area is sheltered by boulders or shallows, only every second fetch line is measured across that shelter.
3. If the area does not face the prevailing wind directions, the effective fetch value is multiplied by a factor of 0.5.
4. If the depth of the area is 2 m or less and if the distance to the 2-meter depth contour is more than 200 m, the effective fetch value is again multiplied by a factor of 0.5.
- 5.

Main class	Effective index modified	fetch (L_f)
Very sheltered	<5	
Sub-division		
Ultra sheltered	0-1	
Extremely sheltered	1-2	
Very sheltered	2-5	
Main class		

Sheltered	5-25
Sub-division	
Sheltered	5-10
Moderately exposed	10-25
Main class	
Exposed	>25
Sub-division	
Exposed	25-50
Very exposed	50-100
Extremely exposed	Over 100

LEVEL 7. FUNCTIONAL GROUP

Main class	Definition
Communities influenced by ice-scraping with little or no vegetation or epifauna	Areas which are normally influenced during the winter by ice-scraping and where the coverage of plants or epifauna is less than 10%.
Sub-types:	
Infaunal communities	Areas with mobile sediments or mixture of mobile sediments and non-mobile substrates influenced normally by ice-scraping during the winter and where the coverage of plants or epifauna is less than 10%. These biotopes are classified according to the infauna (classification missing so far).
Rock or other hard substrata without or little vegetation or epifauna	Areas with rock or other hard substrata influenced normally by ice-scraping during the winter, where the coverage of plants or epifauna is less than 10%. These biotopes are classified according to the substrate.
Main type:	
Communities influenced by ice-scraping and dominated by vegetation or epifauna	Areas normally affected during the winter by ice-scraping, where the coverage of plants or sessile epifauna is at least 10%. Flora consists normally only annual species. Perennial plants or sessile epifauna is normally scraped away by ice at winter
Sub-types	
Filamentous green, brown and red algae zone	Surfaces affected by ice-scraping, where annual filamentous algae coverage during the summer is at least 10% Species composition

	can vary between years and season.
Main type:	
Communities not influenced by ice-scraping with little or no vegetation or epifauna	Areas normally not affected by ice-scraping during the winter and where the coverage of perennial plants or epifauna is less than 10%.
Sub-types	
Infaunal communities	Areas with mobile sediments or mixture of mobile sediments and non-mobile substrates not affected by ice-scraping, where the coverage of plants or epifauna is less than 10%. Biotopes are classified according to the infauna (classification missing so far)
Rock or other hard substrata without or little vegetation or epifauna	Areas with rock or other hard substrata substrates not affected by ice-scraping, where the coverage of plants or epifauna is less than 10%. Biotopes are named according to the substrate. Typical on deep vertical rock faces.
Main type	
Communities not influenced by ice-scraping dominated by vegetation or epifauna	Areas normally not affected by ice-scraping, where the coverage of perennial plants or sessile epifauna is at least 10%.
Sub-types (examples):	
Charas	Visual abundance of Charas represent at least 50% of the visual abundance of all perennial plants or sessile epifauna.
Green algae	Visual abundance of green algae represent at least 50% of the visual abundance of all perennial plants or sessile epifauna
Filamentous brown algae	Visual abundance of filamentous brown algae represent at least 50% of the visual abundance of all perennial plants or sessile epifauna
Red algae	Visual abundance of red algae represent at least 50% of the visual abundance of all perennial plants or sessile epifauna
Fucales	Visual abundance of Fucales represent at least 50% of the visual abundance of all perennial plants or sessile epifauna
Laminariales	Visual abundance of Laminariales represent at least 50% of the visual abundance of all perennial plants or sessile epifauna
Loose algae	Visual abundance of loose growing algae represent at least 50% of the visual abundance of all perennial plants or sessile

	epifauna
Vascular plant	Visual abundance of vascular plants represent at least 50% of the visual abundance of all perennial plants or sessile epifauna
Mussel beds	Visual abundance of blue mussels or other mussels represent at least 50% of the visual abundance of all perennial plants or sessile epifauna
Barnacles	Visual abundance of sessile barnacles represent at least 50% of the visual abundance of all perennial plants or sessile epifauna
Polyps	Visual abundance of sessile polyps represent at least 50% of the visual abundance of all perennial plants or sessile epifauna
Mixture of functional group sub-types	Combination of the two (or more) most abundant functional groups which together represent at least 50 % of the total visual abundance of all perennial plants or sessile epifauna. This is the case when none of the functional groups is abundant enough to alone represent at least 50 % of the total abundance of all perennial plants or sessile epifauna.

LEVEL 8. SPECIES LEVEL 1

Class	Definition
Species level 1	The species level 1 biotope is named according to the dominant species. The species is ranked as dominant when it represents at least 50 % of the total visual abundance of all species at the site. If none of the species is abundant enough to alone represent at least 50 % of the total abundance of all species the species level 1 biotope is formed by the most abundant species and the second (and so on) abundant species which together represent at least 50 % of the total visual abundance of all species at the site.
Examples	
<i>Zostera marina</i>	<i>Zostera marina</i> alone represents at least 50 % of the total visual abundance of all species at the site
<i>Fucus vesiculosus</i>	<i>Fucus vesiculosus</i> alone represents at least 50 % of the total visual abundance of all species at the site
<i>Zostera marina</i> and <i>Potamogeton pectinatus</i>	The two most abundant species <i>Zostera</i>

	<i>marina</i> and <i>Potamogeton Pectinatus</i> together represent at least 50 % of the total visual abundance of all species at the site. None of the species is abundant enough to alone represent 50 % of the total visual abundance of all species at the site. The functional group at level 7 would be “vascular plants”
<i>Fucus vesiculosus</i> and <i>Zostera marina</i>	The two most abundant species <i>Fucus vesiculosus</i> and <i>Zostera marina</i> together represent at least 50 % of the total visual abundance of all species at the site. None of the species is abundant enough to alone represent 50 % of the total visual abundance of all species at the site. The functional group at level 7 would be “mixture of functional group sub-types”

LEVEL 9. SPECIES LEVEL 2.

Class	Definition
Species level 2	The species level 2 can be named only if the second dominant species is abundant enough to represent at least 30 % of the total abundance of all species at the site. The biotope is called as “The dominant species with the co-dominant species”.
Examples:	
<i>Zostera marina</i> with <i>Potamogeton pectinatus</i>	Visual abundance of <i>Zostera marina</i> is at least 50 % of the total visual abundance of all species and the visual abundance of <i>Potamogeton pectinatus</i> is at least 30 % of the total visual abundance of all species

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