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Short Communication



# Habitat Mapping in Coastal Waters of the Baltic Sea -A 14-Years' Experience from Schleswig-Holstein

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## Introduction

Habitats are defined as "areas of the seabed that are (geo)-statistically significantly different from their surroundings in terms of physical, chemical and biological characteristics, when observed at particular spatial and temporal scales" [1]. In the marine domain, they are ranked as high graded ecological environments. Along with the awareness of human impact on the marine ecosphere, the weight of sound habitats for a sustainable environment is recognized [2], requiring research activities on the inventory, capacity, integrity and dynamics of the marine realm. Full coverage maps of sediment distribution patterns and the geomorphological built up are an essential prerequisite for marine nature conservation and marine spatial planning [3]. Those sophisticated cartographic data form the basis for high confidence assessments of the environmental conditions and subsequent monitoring activities, which are demanded by national and international regulations, like the Marine Strategy Framework Directive (MSFD), Water Framework Directive (WFD) and the Habitats Directive (HD). Increasing pressure on the natural development of marine habitats due to human impact (dredging, dumping, relocating pipelines, establishing offshore windfarms, fisheries and other uses) is observed, creating disturbance and degradation of their natural development. Strategies for mapping programmes have been developed in many countries to meet the requirements for detailed habitat maps, but progress in habitat inventory and management varies widely, often due to different nomenclatures, poor infrastructure and a lack of guidelines and standardized schemes.

Hard bottom substrates are important habitats for zoo- and phytobenthic species in the southern and south-western Baltic Sea [4]. These deposits are remnants of the last glaciation. Hydrodynamic processes have shaped these deposits during the Holocene, when the Baltic Sea evolved through a set of different lacustrine and brackish water stages; a process, which continues in the presence. As a result, abrasion platforms were formed building geomorphological heights, which are partly covered by stones, gravel and thin veneers of sandy material up to 30 cm thick. These veneers are not stationary but dynamic according to prevailing hydrodynamic conditions. The geomorphological heights are either connected to the land and in this case, they are bordered by active cliffs, or they form morphological elevations in the open sea, disconnected from to coastline. In any case, they are exposed to wave conditions at least during storms. In both cases, a belt of sandy sediments resulting from abrasion processes, which started when the postglacial sea level has reached a height allowing wind induced waves and currents to shape the seafloor, surrounds these areas. The EU Habitat Directive 92/43/EEC [5] addresses those abrasion platforms as "reef".

Like in many countries, a comprehensive knowledge of the seafloor conditions, which is required to identify precisely different habitats, did not exist. We started our habitat inventory by developing a three-step approach ranging from identifying "probable habitat areas" to "precisely defined habitat areas" where "probable" areas are always larger in space than the precisely defined areas [6].

**Step 1:** Collection of all available information for a selected area from scientific as well as public agencies and institutions for a selected area. In our approach this included bathymetrical charts (1), internal and official reports (9), MSc- and Diploma-thesis (22), PhD thesis (6), Habilitation (1) and publications (9). All data have been compiled in a GIS system, which produces a map showing areas suspected to have the potential to be regarded as habitat according to the EU-Directive.

**Step 2:** Geoscientific ground-truthing by high resolution mapping campaigns with hydroacoustic remote sensing techniques, underwater video observations and sediment sampling and analyzing, which allowed to map and to explore the sedimentological properties of the seabed. Full coverage backscatter information was collected using side scan sonars with different frequencies (TTV-298, Teledyne Benthos, 200 kHz, Benthos 1624, 100 and 400 kHz). An Acoustic Ground Discrimination System (AGDS) ECHO plus (Seatronics Ltd., 200 kHz) was applied to measure "roughness" and "hardness" of the seabed. Visual observations were performed using a ROV system (Video Ray) and a dropped video camera. ROV position were obtained by USBL (ultra-short baseline), while drop-camera flights were referenced to the actual ship location. Information of the sub-bottom architecture was collected using a sub-bottom profiler and a parametric sediment echo-sounder. Sediment samples were collected with a Van-Veen grab sampler. Depending on the sediment composition, sieving or laser granulometry was used to obtain grain size distributions. All processed data were classified and transferred into seabed types [7].

**Step 3:** Biological validation needs to be carried out by in situ sampling (grab sampler, diving observations) and visual remote sensing techniques. Until now, there has been a delay in the collection of the remaining data to finalize step 3, as those field campaigns are time consuming, even when they are based on the available geoscientific data.

The area which was full coverage mapped with high resolution during the last 14 years comprises about 1.540 $km^2$ and range from 5 m to 25 m water depth. Large areas in the SW Baltic Sea are identified as typical abrasion platforms, showing characteristic substrates and habitats. The most prominent geomorphological manifestation is a hard bottom substrate composed of morainic material. This type corresponds to the definition of a "reef" [8], which is of geogenic origin in the Baltic Sea. Thin veneers of sandy material can occur on these hard bottom platforms. They are often elongated with a width of meters and a length of tens of meters and vary in their thickness, but seldom exceeding 30- 40 cm. These sandy veneers are mobile. For this reason, they are not classified as sandbanks according to the Interpretation Manual of the EU [8]. Thicker sandy deposits exist, filling up former channels or depressions which developed during the Holocene evolution of the Baltic Sea. These deposits are not elevated but on the same morphological level as the surrounding seafloor. Since the definition of a sandbank requires a certain height in relation to the surrounding seafloor [8], these deposits are also not defined as sandbank, even if benthic communities depending on sand as their substrate is observed.

The apparent zonation of seabed types from shallow water with abrasion platforms via their surroundings composed of sandy deposits to the deeper parts built up by muddy sediment and their including benthic organisms indicate a strong link to the geological subsurface and the recent sediment dynamics. The exposure of platforms and ongoing wave and current induced abrasion processes with rates in the range of cm/year supports an increase of the availability of hard-bottom substrate in the future.

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## Conflict of Interest

Author declares no conflict of interest

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