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Verifying a biotope classification using benthic communities – An analysis towards the implementation of the European Marine Strategy Framework Directive

Kerstin S. Schiele *, Alexander Darr, Michael L. Zettler

Leibniz Institute for Baltic Sea Research Warnemünde, Seestr. 15, 18119 Warnemünde, Germany

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ABSTRACT

The HELCOM Red List biotopes project proposed a Baltic Sea wide classification consisting of six levels: The HELCOM Underwater biotopes/habitats classification system (HELCOM HUB). We present a case study from the south-western Baltic Sea where we tested the applicability of this system. More than 500 sampling stations were analyzed regarding macrozoobenthic communities and their linkage to environmental parameters. Based on the analyses of biotic and abiotic data, 21 groups were assigned to 13 biotopes of the classification. For some biotopes varying states of communities were recognized. Even though not all abiotic parameters are considered directly in the hierarchy of the classification in general, all soft-bottom communities could be allocated to a corresponding biotope. The application of the HELCOM HUB for the south-western Baltic Sea is feasible, in regard to the implementation of the European Marine Strategy Framework Directive as well as the Baltic Sea Action Plan.
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1. Introduction

The European Marine Strategy Framework Directive (MSFD) aims at reaching a good environmental status (GES) for all European seas by 2020. Predominant and special marine habitats shall be assessed and measures are to be taken in case a good status is not reached (European Commission, 2008). For this purpose information on habitats and habitat maps are being used at various steps: to determine GES for descriptors 1 (biodiversity) and 6 (seafloor integrity), and to describe characteristics of, as well as pressures and impacts on predominant habitats, special habitats and their respective biological features (Borja et al., 2010). A basic requirement to assess the status of habitats is a classification system. The need for a typology which is not only comparable among European Seas, but consistent within each respective sea has been emphasized in recent studies (Galparsoro et al., 2012; Villnäs and Norkko, 2011). Biological components need to be incorporated in a classification to ensure that ecologically meaningful habitats are mapped (Diaz et al., 2004). Therefore, a biotope classification rather than a habitat classification is demanded.

The European Nature Information System (EUNIS) was developed for all European biotopes on land and at sea (Davies et al., 2004). At a national level, many habitat mapping studies have encountered difficulties with the applicability of the system in the field (Galparsoro et al., 2012; Busch, 2005). Since the development of EUNIS in 2004, it has been recognized that among others, the Baltic Sea was poorly represented in the classification (Galparsoro et al., 2012). Contrasting marine regions do not show global consistencies in compositional responses along environmental gradients (Pitcher et al., 2012). To overcome regional differences biotope classifications may be developed in the respective regional seas (Galparsoro et al., 2012). Regional seas conventions (e.g. OSPAR, HELCOM) and methods designed under these frameworks will be the tools to implement the MSFD (European Commission, 2008).

The HELCOM Red List biotopes project developed a proposal for a Baltic Sea wide typology of marine biotopes: The HELCOM Underwater biotopes/habitats classification system (HELCOM HUB) (HELCOM, 2013). This classification differs from the BaltEUNIS classification (Leinikki, 2011; Wikström et al., 2010) that has been previously proposed for the Baltic Sea. HELCOM HUB is a hierarchical classification system and consists of 6 levels (levels 1–6): (1) Baltic, (2) vertical zones, (3) substrate, (4) community structure, (5) characteristic community, (6) dominating taxa. At each level, splitting rules to the next level are defined. The HELCOM system has been constructed to be compatible with EUNIS and retains its basic structure. However, in benthic habitats, it refrains from the conventional subdivision into infra-, eu-, and sublittoral. Instead, the HELCOM HUB distinguishes a photic and an aphotic zone accounting for the availability of light at the bottom of the

* Corresponding author. Tel.: +49 3815197423; fax: +49 3815197211.
E-mail addresses: kerstin.schiele@io-warnemuende.de (K.S. Schiele), alexander.darr@io-warnemuende.de (A. Darr), michael.zettler@io-warnemuende.de (M.L. Zettler).

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sea. On level 3, sediment characteristics are of importance and on level 4 the occurrence of biotic structures such as vegetation or fauna are important. In macrozoobenthic biotopes, infaunal or epifaunal communities and the most dominant species regarding biomass determine level 5 and level 6. As distinct biological communities should be the basis for ecological classifications (Remane, 1934), setting communities as the measure at the highest level of the classification is sensible. In this study, the terms 'habitat', 'biotope' and 'community' are used sensu HELCOM (2013).

In order to fulfill the requirements of the MSFD each EU Member State must be able to identify its biotopes within a classification system. It is an issue of scale to represent all relevant biotopes in a meaningful way (Thrush et al., 2005). A large-scale biotope classification encompassing the whole Baltic Sea may not necessarily be suitable to describe biotopes in every region. Therefore, a regional analysis of the proposed system is necessary. First of all, distinct communities in the respective region need to be distinguished. Subsequently, it can be tested whether corresponding biotopes can be identified. This study is the first to apply the proposed HELCOM classification to extensive community field data.

The focus was on predominant habitats in offshore waters. The aim of the study was to clarify whether the typology developed by HELCOM, especially level 6 biotopes, is a suitable system for biotopes in the southern Baltic region. The study identifies predominant and to some extent special habitats and points to potential approaches concerning subsequent assessment.

2. Materials and methods

2.1. Study area

This study focuses on macrozoobenthic communities in the SW Baltic Sea (Fig. 1). The bulk of sampled stations lie within German waters. The area is characterized by a salinity gradient from 25 PSU in the westernmost (Kiel Bight) to 5 PSU in the easternmost parts (Pomeranian Bay). Seasonal hypoxia occurs in Kiel Bight and Bay of Mecklenburg (HELCOM, 2009; Zettler et al., 2000). Sediment maps of the German Baltic Sea (Tauber, 2012) show that soft bottoms prevail in the region.

2.2. Sampled benthic data

526 sampling stations were analyzed for benthic community data including environmental parameters collected during the years 2004–2011 (Fig. 1). Samples were taken from February until November, with the majority of them being collected during spring and summer.

Benthic samples were collected with a van Veen grab (0.1 m^2). Each location was sampled three times per sampling event for biotic analysis and a fourth time for sediment analysis. Biotic grab samples were wet-sieved through a 1 mm mesh and preserved in 4% formol–seawater solution. Species were counted, weighed and identified to the lowest possible taxon in the laboratory. Sediment samples were analyzed for median grain size, mud content (=frac tion < 63 μm, RETSCH sieving machine, CILAS 1180 Laser Particle Analyzer) and total organic content as loss on ignition (LOI, 5 h at 500 °C).

Additionally, parameters such as bottom salinity (PSU), oxygen (ml/l) and depth (m) were recorded at each station.

2.3. Modeled environmental parameters

Data of salinity (mean, standard deviation), bottom temperature (mean winter DJF, mean summer JJA), velocity (mean, max.) and bottom stress (mean, max) were obtained from the simulations of Klingbeil et al. (2013). Values were calculated as annual mean averaged over a period of 7 years from 2003–2010. The horizontal resolution of the model grid is about 600 × 600 m (Klingbeil et al., 2013). Data on oxygen depletion (average number of days/year < 2 ml/l) and light penetration depth (LPD, averaged over the growth period from March until October) were obtained from an adjusted version of the ERGOM model described in Neumann (2000) and Friedland et al. (2012). The spatial resolution was one nautical mile. LPD was defined as the depth where 1% of photosynthetically active radiation was available. The LPD was superimposed with the bathymetry to separate the aphotic and the photic zone. All modeled abiotic parameters were joined to benthic community data at sampling stations using ESRI ArcGIS10.

2.4. Data analysis

For the analysis of benthic communities 526 sampling stations were considered. In order to produce datasets suitable for various statistical analysis all species present with less than 5 individuals and some not to the species level identified higher taxa (Halacaridae, Nemertea, Oligochaeta, and Turbellaria) were omitted. Also *Mytilus* was excluded from community analysis as it was tested as an environmental factor in subsequent analysis. Prior to analysis, biotic data were fourth-root transformed (Lozán and Kausch, 1998) to weight down the effect of dominant species.

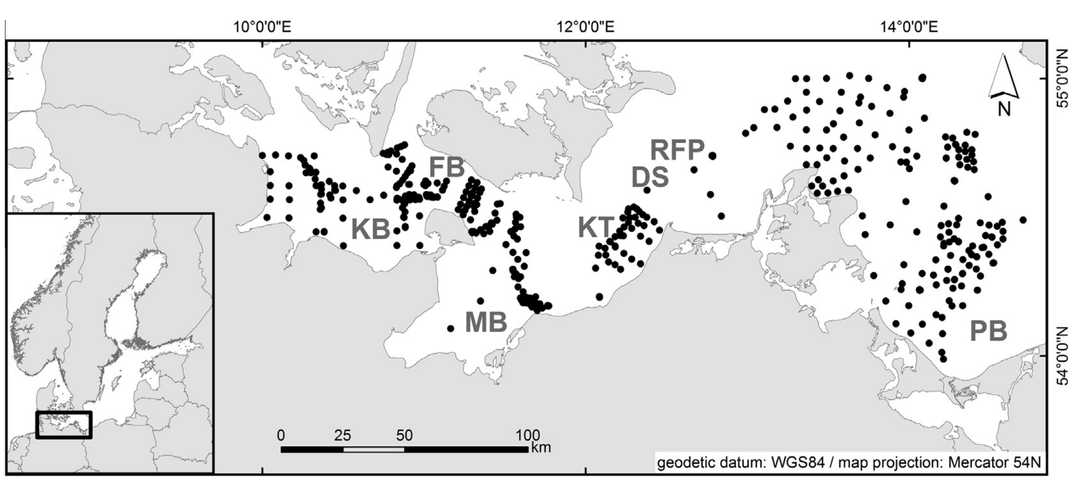

Fig. 1. Study area with 526 sampling stations. DS = Darss sill, FB = Fehmarnbelt, KB = Kiel Bight, KT = Kadet trench, MB = Bay of Mecklenburg, PB = Pomeranian Bay, RFP = Ruegen–Falster plate.

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