

Assessment of quality of three marine benthic habitat types in northern Baltic Sea



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ABSTRACT

The European Union Habitats Directive (HD) obliges member states to assess the conservation status of marine habitat types but no explicit methodologies for assessing the quality of habitats have been stated in the directive or accompanying documents. In this study, a system was developed to assess the structure and functioning of three important marine habitat types in the Estonian sea area: sandbanks (HD code 1110), mudflats (1140), and reefs (1170). The assessment system includes a list of ecological criteria and favourable reference values together with procedural rules and field sampling locations. The habitat types listed in the HD are broadly defined and may encompass different communities depending upon distinct environmental gradients. By considering these environmental gradients the habitat types reefs and sandbanks were zoned and the assessment criteria and corresponding favourable reference values were defined separately for each zone. A set of several metrics like benthos indices, community variables, presence of sensitive or typical species, proportions of functional or taxonomic groups were tested as potential criteria for determining habitat quality. The most appropriate criteria were selected for incorporation into the assessment system based on ecological eligibility, suitability to local conditions, occurrence rates of benthic species, responses to disturbances, statistical properties of distribution of measured values, and practical considerations. Extensive benthos database (records from the whole Estonian sea area, 1995–2014) was used to calculate values of criteria to support the selection of criteria and to derive reference values. In order to fully take into account their crucial role in maintaining the structure and functioning of habitats, the criteria on habitat-forming species were assigned higher hierarchical order in the assessment scheme compared to other criteria. Special field works were carried out to assess the status of the three habitat types in 2015. The quality of all three monitored habitats was assessed to be in a favourable status. Additionally, the distributions of the three habitat types were mapped. To date, this is the first study in the Baltic Sea region that formulates HD compliant explicit criteria, reference values, and assessment procedures for several marine habitat types. The main challenges of the study were to derive assessment criteria and favourable reference values that are ecologically relevant and practically feasible.

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1. Introduction

Marine benthic habitats in coastal areas are complex systems with a high degree of heterogeneity and patchiness which are often subjected to high temporal dynamics (Ogburn et al., 2011; Gamito et al., 2012). Benthic habitats are considered as important drivers of diversity and therefore the modification or loss of habitats are considered as serious threat to marine ecosystems (Sih et al., 2000; Airoldi and Beck, 2007). Due to heterogeneity of habitats and

limited available data, the monitoring of habitat status is a great challenge for ecological assessment programmes (Schiele et al., 2015; Sahla et al., 2016). Further challenges, common to different kinds of assessments of natural environments, are the determination of ecologically relevant assessment criteria and setting of relevant borderlines between status classes (Birk et al., 2012; Borja et al., 2013).

In European Union (EU) the conservation of valuable or threatened habitats, animals and plant species are regulated by the Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora, hereafter Habitat Directive (HD). The HD requires monitoring and reporting of the conservation status of the selected natural habitats and species

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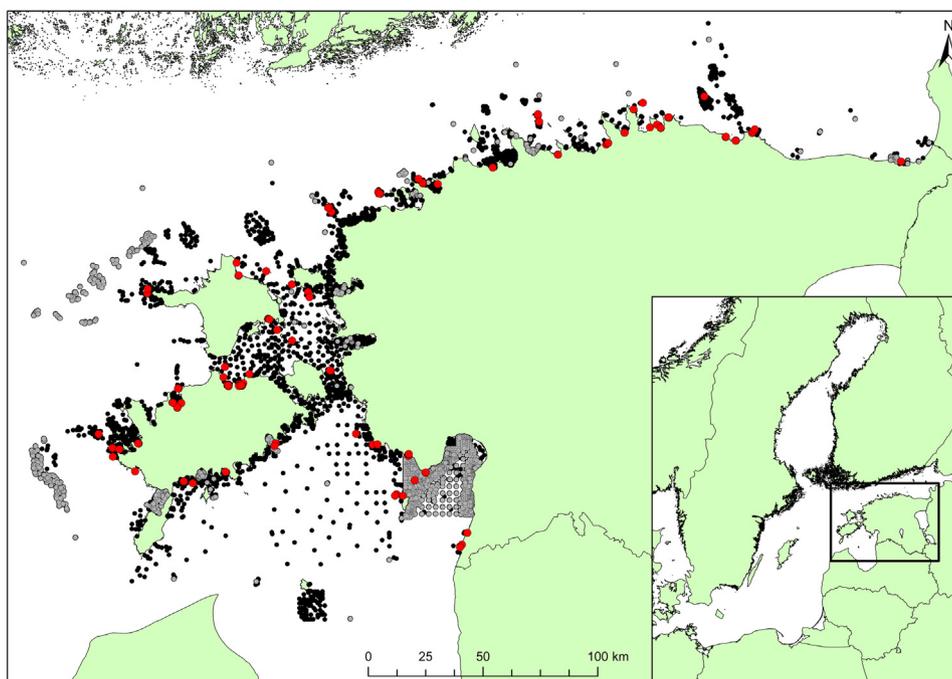


Fig. 1. Distribution of the sampling locations (1995–2015) in Estonian sea areas. Data used for defining reference values are marked in black, targeted habitat monitoring sampling stations for quality assessment are marked in red; grey markers indicate all other sampling sites that were additionally used for creating the distribution maps of habitats. (For interpretation of the references to color in the text, the reader is referred to the web version of this article.)

within the whole territory of the member states every six years (European Communities, 1992). The first assessment (reporting period 2001–2006) was expected to be based on the best available data and expert opinion. Targeted special monitoring programmes were expected to be established for the second assessment period 2007–2012 (Walder et al., 2006). However, the targeted monitoring programmes and assessment systems are still under development in the majority of the member states (European Commission, 2015; Louette et al., 2015). According to the last reports, knowledge on the marine habitats and species remains poor and their monitoring requires a significant additional effort (European Commission, 2015). To date, published scientific studies that present a complete HD assessment system are totally lacking.

The HD calls for a periodic assessment of the conservation status for habitat types and species. According to the HD conservation status of habitat types requires information on four parameters: range of distribution, area of distribution, structure and function of habitat (quality of habitat hereafter) and future prospects. There are three status levels for each parameter: favourable (FV), unfavourable-inadequate (U/I) and unfavourable-bad (U/B). Habitat type is considered to be in a favourable conservation status (FCS) when the natural range of habitat type is stable or increasing, long-term survival of specific structure and functions is considered secure and the status of its typical species is favourable (European Communities, 1992; Evans and Arvela, 2011). Assessment of the habitat should be based on the monitoring of representative sites, and include monitoring of specific community structures and function (Mehtälä and Vuorisalo, 2007). Therefore, to assess the quality of a habitat a set of habitat-specific criteria and their reference values should be established. Criteria and reference values need to be based on scientific grounds (Evans and Arvela, 2011; Louette et al., 2015). Currently, there is no published information available concerning the assessment of the quality of marine habitats in the Baltic Sea or neighbouring areas (Louette et al., 2015).

Altogether seven marine habitat types in the coastal area of the Baltic Sea are listed in the HD Annex I as natural habitat types

of community interest (European Communities, 1992). The current study focuses on three out of six marine benthic habitat types described for the Estonian waters – sandbanks (1110), mudflats (1140) and reefs (1170). Sandbanks are considered valuable habitat as they host rare or threatened species and are similarly with mudflats important spawning, nursery and feeding areas for fish and feeding areas for water birds. Reefs are ecologically significant because they sustain high biodiversity and high benthic primary production, they are important feeding areas for fish, birds, and seals, and spawning and nursery areas for fish (HELCOM, 1998; Boedeker et al., 2006). Previous assessments of habitat range and quality in the Estonian coastal sea have been based on the interpretation of incomplete spatial data combined with expert opinion (European Commission, 2015).

The aim of this study was to develop assessment criteria, to determine favourable reference values for these criteria and to propose a clear, easy to follow methodology for the assessment of the conservation status of habitat quality according to the HD requirements. To account for the variability in the community structure along environmental gradients, ecological zoning was established for each of the assessed habitats. The assessment criteria and favourable reference values were established specifically for these ecological zones. Additionally, distribution maps of the three marine benthic habitats in the Estonian waters were presented based on dataset available from previous inventories and modelling studies.

2. Materials and methods

2.1. Study area

The study area includes the whole Estonian marine area, northern Baltic Sea (Fig. 1). The Estonian marine areas include parts of the Gulf of Finland, the Gulf of Riga, the whole West Estonian Archipelago Sea and part of the Baltic Proper. Salinity is constantly low, varying between 2 and 8 in the surface layers, whilst major

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