Predictive Mapping of Benthic Communities and Species for the German North Sea

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Summary
The goal of the talk is to present current benthic biotope mapping activities in the German North Seal funded by the Federal Agency for Nature Conservation. Benthic communities were derived from abundance data compiled in a database including more than 70,000 species records. Different cluster algorithms were applied resulting in six significant groups corresponding to mostly known soft bottom benthic communities as documented in the scientific literature. These communities were mapped with help of predictive modelling techniques in terms of both the communities’ distribution and mapping uncertainty for a 600 m x 600 m raster. The same mapping methodology was applied on chosen benthic species relevant for nature conservation issues. Both communities and species represent classification criteria of a currently developed classification system for benthic biotopes in the German Exclusive Economic Zone of the North Sea. Future works will concentrate on the further development of the classification system, the improvement of the data basis as well as on the optimisation of the mapping of communities and species on different spatial scales.

Introduction
In European marine waters biotope maps are urgently needed to meet the requirements arising from different provisions of the European Union and national laws such as the Habitats Directive, the Marine Strategy Framework Directive and the Federal German Nature Conservation Act. In Germany’s Exclusive Economic Zone (EEZ) these maps are currently produced in a project funded by the Federal Agency for Nature Conservation and respective institutes involved (Pesch et al. 2014). The mapping thereby relies on existing and newly collected benthos and sediment data as well as on further geodata relevant to assess the spatial heterogeneity of the abiotic and biotic conditions at the ocean floor. All acquired and produced data are to be classified by use of a currently developed classification system for benthic environments of the German North Sea. The talk at hand summarises the first phase of the project carried out between 2012 and 2014 with special emphasis on the mapping of benthic communities and species.

Materials and Methods
The full coverage biotope mapping in the North Sea EEZ relied on a first draft of a classification system for biotopes in the German North Sea similar to that of the European Nature Information System (EUNIS – Davies et al. 2004) and the HELCOM Underwater biotope and habitat classification system (HELCOM HUB - HELCOM 3013). Accordingly, the system is structured into six hierarchical levels of which the upper three levels (biogeographical region, vertical zones, substrate types) contain abiotic and the lower three levels (biotope struc-
tures, biotope types, subbiotope types) contain biotic classification criteria. Whereas the first three levels could be mapped by full coverage data made available from national and international agencies and projects no such data was available regarding benthic ecological classification criteria. Hence, predictive modelling techniques were applied to map benthic variables of interest by use of a benthos database including more than 70,000 species records. The modelling thereby concentrated on benthic soft bottom communities to map biotope types and on chosen benthic species relevant for nature conservation issues. The benthic communities were at first calculated by use of fuzzy cluster algorithms applied on the site specific benthic sampling data (Fiorentino et al. in prep.). Both communities and species data were then intersected with full coverage geodata on topography, sediments, physical and chemical properties of the water column and possible anthropogenic pressures. Statistical associations were quantified in terms of Random Forest models and then applied on the full coverage information to map benthic communities and species for the German North Sea. The mapping was done on a broad scale in terms of a 600 x 600 m raster.

Results and Discussion
Biotope mapping was carried out according to a draft biotope classification system for the sea floor of the German North Sea relying on six hierarchical levels. Regarding the lower biotic classification levels, full coverage maps of biotope types could be derived in terms of the spatial distribution of six benthic communities for soft substrates using cluster analyses and predictive modelling techniques. As a result, the derived benthic groups mostly reflect scientific knowledge on the occurrence of such communities in the German North Sea since five of the six communities are already documented in the scientific literature. The full coverage mapping of the soft bottom communities was performed by application of the decision tree algorithm Random Forests. In this way the uncertainty of their occurrence could be quantified in terms of misclassification and confusion index maps. The same methodology was applied on chosen benthic species relevant for nature conservation issues. Next to the further development of the biotope classification system for benthic environments in the German North Sea, future project works will concentrate on mapping biotope and subbiotope types by use of high resolution substrate maps produced from hydroacoustical data. Furthermore, additional data on benthic organisms will have to be sampled and acquired in areas with low data densities. The same holds true for full coverage secondary information that may improve the predictive models for benthic species and communities.

References