Chapter 8
Collaborative Seabed-Habitat Mapping: Uncertainty in Sediment Data as an Obstacle in Harmonization

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ABSTRACT
This chapter discusses the uncertainties associated with sediment data, which are a commonly neglected obstacle in collaborative seabed-habitat mapping, complicating harmonization. Standardization of these data, although an important prerequisite in the harmonization of surrogate-based habitat maps, is not enough to achieve full map uniformity. Through time and between research institutes, data have been acquired, described, analyzed, and classified using a range of methods and protocols. The effects of differing error margins and indicative meanings remain hidden for most end users in environmental science and policy. The interpolation required to generate full-coverage data products from sedimentological point data creates additional uncertainty. Finally, small-scale habitat heterogeneity not captured by even the densest sampling places limits on the usability of sediment-based surrogates as well. Despite these limitations, there is much room for improvement when it comes to using surrogates in habitat mapping. Multiple visualizations generated from merged digital sediment datasets with flexible querying protocols are especially promising.

INTRODUCTION
There is international political momentum for the safeguarding and conservation of seabed biodiversity that is under increasing pressure from human activities such as fisheries, aggregate extraction, dredging and disposal of sediment, and wind-farm development. In this light, the extent and overall status of marine habitats must be assessed quantitatively. High-quality ecosystem and seabed-habitat maps are needed to spatially plan human activities and to designate marine protected areas at the most
suitable locations. Effective integrated coastal and marine management compliant with the European Marine Strategy Framework Directive, Habitat Directive, and Water Framework Directive requires a transnational approach. Common, internationally agreed metadata and data standards are viewed as key elements in the harmonization of data products such as habitat maps, but adherence to these standards does not suffice in generating seamless habitat maps. Numerous acquisition and analytical protocols, each with their own uncertainties, preclude full harmonization. Their influence on the quality and indicative meaning of data, which differs from one dataset to the next, is difficult to quantify and usually not considered by data managers and map makers. Uncertainties related to sampling, subsampling, description, analysis and data interpolation form potential sources of error that will translate into mismatches in transnational sediment maps.

A specific challenge in harmonization concerns the common use of sediment-related surrogates in habitat mapping. Surrogates are biophysical variables that can be mapped with a quantifiable correspondence to the occurrence of benthic species and communities (Harris, 2012a). Since determining the distributions of key species of seafloor habitats directly is costly, physical seafloor parameters are frequently used as proxies of biological diversity and as indicators of habitat suitability. Abiotic variables, including morphological and sedimentological parameters, have been measured and monitored for many decades. Collection of morphological and sedimentological data is relatively easy and more cost-effective than the acquisition of data on seabed species and assemblages. In a stepwise, multi-faceted approach, various abiotic characteristics can be measured directly in the field or in the laboratory, documented by visual description, or deduced indirectly using remote-sensing techniques. The biological relevance of both the surrogates used and the divisions or classes defined within each surrogate is commonly unknown or merely assumed. Even where established quantitatively, the validity of observed biotic-abiotic relationships may not extend far beyond the area of consideration, as other variables may become more important. In short, potential habitat suitability as derived from a limited number of surrogates does not translate directly into actual habitat distribution.

Within the context of valorizing geological data for habitat mapping, Van Lancker & Van Heteren (2013) and Dolan et al. (2013) showed how sediment and terrain characterization respectively provide relevant knowledge about benthic habitats. They emphasized the need for standardization and harmonization, discussing principal methodological approaches and classification systems. Case studies presented as part of the two reviews illustrate how different data resolutions affect the granularity of sediment and terrain characterization. Here, we further elaborate on uncertainties related to sediment data, on seabed heterogeneity, and on up- and downscaling issues that need to be considered when merging adjacent regional data products. We illustrate how these issues may translate into mismatches linked in part to inconsistent definitions and vocabularies. Common standards, which would eliminate these inconsistencies, are a first prerequisite in unlocking the full potential of seabed-sediment databases. There is an equally important need, however, to consider differences in quality and indicative meaning related to a multitude of acquisition, description, analysis and interpolation methods and protocols.

**STANDARDIZATION AND HARMONIZATION IN SEABED-HABITAT MAPPING**

A seafloor habitat is “a particular environment [on the seafloor] that can be distinguished by its abiotic characteristics and associated biological assemblage, operating at particular, but dynamic spatial and temporal scales in a recognizable
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