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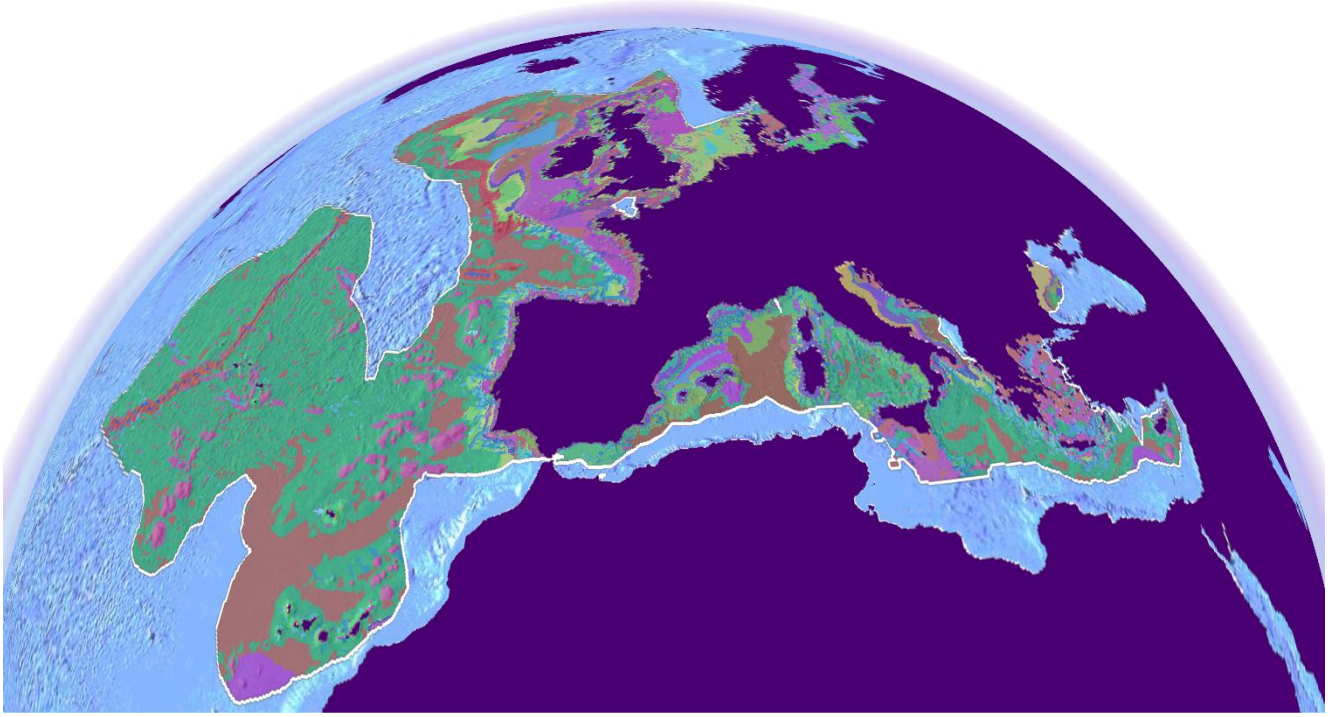

Bringing together harmonized EUNIS seabed habitat geospatial information for the European Seas

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Abstract
The EUNIS-compliant information on Seabed Habitats that is currently available from the EMODNET portal covers only about half of the European Union (EU) waters in the Northeast Atlantic and adjacent Seas. This work focused on expeditiously obtaining a comprehensive coverage of permanently submerged seabed habitats (i.e., EUNIS classes A3 to A6) throughout this area for purposes of mapping seabed-related ecosystem functions and services. This was achieved by bringing in, and harmonizing where needed, complementary EUNIS-compliant broad-scale geospatial information from the UNEP's Global Seafloor Geomorphic Features Map (GSGFM). The new geospatial dataset obtained, a polygon shapefile, extends for approximately 8.7 million km^2 and more than doubles the coverage of EUNIS seabed habitat classes when compared to the datasets available from the EMODNET portal. It details more than 90% of the EU waters down to EUNIS level 2 and 3 and a small part down to level 5. It significantly improves EMODNET datasets by populating the deep-sea and offshore areas with previously disregarded geomorphic-based EUNIS habitat classes. The methodology and some area-based statistics on seabed habitats are presented, including overall and basin-specific mapped extents.

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Synopsis

The EUNIS-compliant information on Seabed Habitats that is currently available from the EMODNET portal covers only about half of the European Union (EU) waters in the Northeast Atlantic and adjacent Seas with EU outermost regions in other parts of the Atlantic or in the Indian Ocean still remaining out of the exercise. These gaps limit the geographical comprehensiveness of any studies on seabed-related Ecosystem Functions and Services. However, separate broad-scale seabed habitat mapping sources offer complementary seabed-related geospatial information that can be straightforwardly or, after some basic GIS processing, translated into EUNIS classes.

This work focused on expeditiously obtaining a comprehensive coverage of permanently submerged seabed habitats (i.e., EUNIS classes A3 to A6) throughout most of the EU marine waters. This was achieved by bringing in, and harmonizing where needed, complementary EUNIS-compliant broad-scale geospatial information from the UNEP's Global Seafloor Geomorphic Features Map (GSGFM).

The new geospatial dataset obtained, a polygon shapefile, extends for approximately 8.7 million km^2 and more than doubles the coverage of EUNIS seabed habitat classes when compared to the datasets available from the EMODNET Seabed Habitats portal. It details more than 90% of the EU waters down to EUNIS level 2 and 3 and a small part down to level 5, improving EMODNET datasets by populating the deep-sea and offshore areas with previously disregarded geomorphic-based EUNIS habitat classes. Conversely, it is acknowledged that the GSGFM data could did not bring in any relevant information concerning EUNIS shelf habitats.

The methodology and some area-based statistics on seabed habitats are presented, including overall and basin-specific mapped extents. It is noted that the mapping and quantification of several habitat extents are still geographically biased and underestimate the actual extent of the habitat. A comprehensive and homogeneous coverage of all EU seabed is expected in 2016 from the EMODNET Seabed Habitats programme. Until then, the current synthesis may constitute a valuable dataset for assessing the distribution of many EUNIS seabed habitat classes in EU waters and pursuing spatially-explicit analysis of seabed-related Uses, Functions and Services.

1. Introduction

1.1 EUNIS classification

The EUNIS Habitat classification is a comprehensive pan-European system maintained by the European Topic Centre on Biological Diversity for the European Environment Agency (ETC-BD/EEA) and the European Environmental Information Observation Network (EIONET). It aims to describe and classify in a hierarchical framework all types of habitats in the whole of the European terrestrial, freshwater and marine domains, including both natural and artificial ones. Biogeographically, it covers the European mainland as far east as the Ural Mountains, the Caucasus and Anatolian Turkey. Seawards it extends as far as Iceland, the Macaronesian archipelagos and the Mediterranean islands of EU Member States.

For the purposes of EUNIS, 'habitat' is defined as: “plant and animal communities as the characterising elements of the biotic environment, together with abiotic factors (soil, climate, water availability and quality, and others), operating together at a particular scale”. The factors included in the definition are addressed throughout the hierarchical framework of the classification, producing classification categories which are abiotic down to level 3 and gradually integrate more detailed biological criteria beyond this level. For a detailed description and criteria diagrams see Davies and Moss (2004). The current version of the classification (v. 2007) is available at http://www.eea.europa.eu/themes/biodiversity/eunis/eunis-habitat-classification/habitats/eunis-habitats-complete-with-descriptions.xls.

In view of the progress made in the past decade by projects that better catalogued, characterized and mapped shelf and deep-sea habitats in European seas (e.g., CoralFish, HERMIONE, MESMA, MeshAtlantic) a series of interested parties are currently working on updating and refining the marine sector of the EUNIS classification. Considerable additions in terms of habitat types and revisions to the hierarchical structure are thus expected along the next few years which will require a revision of the results presented below.

1.2 EUSeaMap mapping

The main environmental variables regulating seabed habitat distributions include substrate type, depth, light availability, salinity and hydrodynamic energy. Where geospatial data on these drivers are available, it is possible to produce a ‘predictive map’ of expected EUNIS seabed habitats. A desktop-based methodology for doing this consistently across biogeographic regions was shaped under project MESH and BALANCE and disseminated during the first phase of EUSeaMap. In brief, this approach, hereafter named the “EUSeaMap approach”, uses (i) statistical analysis to establish biologically-relevant thresholds and (ii) Geographical Information Systems (GIS) to perform qualitative map algebra of harmonised environmental rasters divided into classes [for details see Coltman et al. (2008) and Vasquez et al. (in press)]. Common input layers are rasters of seabed substrate types and depth-related biological zones. Depending on the basin, layers of hydrodynamic energy levels, salinity and/or temperature are also taken into account. The ‘layering’ of the classified data in GIS generates classes that represent the different combinations of multi-factor environmental ranges structuring the EUNIS seabed habitat classification down to level 3 or 4. Beyond these levels, finer information on the biological cover of the seabed is usually needed to categorise the habitats. This is typically achieved by bringing in quantitative survey data on the macrophytes and/or the macrofauna dominating the benthos, usually from samples representing between 1 m^2 and 100 m^2.

Disseminated from 2009 onwards, this desktop-based modelling technique to classify habitats in terms of physical parameters has represented an efficient way of producing full-coverage habitat maps at reasonable costs in short time frames. The EUSeaMap I programme and project MeshAtlantic used this approach to produce predictive broadscale benthic habitat maps for: the

Celtic Seas, Greater North Sea, Baltic Sea, western Mediterranean, southwestern Europe Seas and the Azores.

Despite these efforts, the datasets available [pooled in the publicly-open European Marine Observation and Data Network (EMODnet) portal] cover only around half of the European Seas.

1.3 Aims

This exercise focused on bringing together, and harmonizing where need, EUNIS-compliant compatible and complementary broad-scale geospatial information on marine habitat distribution. The work focused on expeditiously obtaining a comprehensive coverage of permanently submerged seabed habitats (i.e., EUNIS classes A3 to A6) throughout most of the EU Seas. This exercise was conducted in preparation of a proxy-based mapping of seabed-related marine ecosystem services in the EU waters of the Northeast Atlantic and adjacent Seas.

2. Methods

2.1 Study area

The exercise extended between the European shores and the following seaward limits:

(i) in the Baltic Sea, North Sea, Mediterranean Sea, Black Sea, the geographical median lines defined between countries baselines;
(ii) off the Canary Islands, the 200nm limit
(iii) (ii) in the remaining Northeast Atlantic area, the limits of the merged Extended Continental Shelf areas claimed by EU Member States.

Shorelines were delimited using the Global Self-consistent Hierarchical High-resolution Shorelines (GSHHS, version 2.2.2, 1/1/2013; GSHHS_f_L1 shapefile), available for download from http://www.ngdc.noaa.gov/mgg/shorelines/gshhs.html. Seaward limits were based upon the Maritime Boundaries of the World dataset (version 8, 28/2/2014) available for download from http://www.marineregions.org/downloads.php. Extended Continental Shelf (ECS) limits were based on GRID-Arendal's compilation of ECS proposals submitted to UNEP's Shelf Program available from http://continentalshelf.org/onestopdatashop/4204.aspx.

A total maritime area covering 8,996,398 km^2 extending throughout the Northeast Atlantic and Adjacent Seas was targeted (**Figure 1**). These limits and spatial extent, hereafter referred as the Study Area, are used for analytical purposes.

The quantitative information presented hereafter, as well as the cartographic representations, do not in any way represent an official position or statement by the European Commission or the Joint Research Centre regarding the maritime territory of EU Member States or other sovereign States.

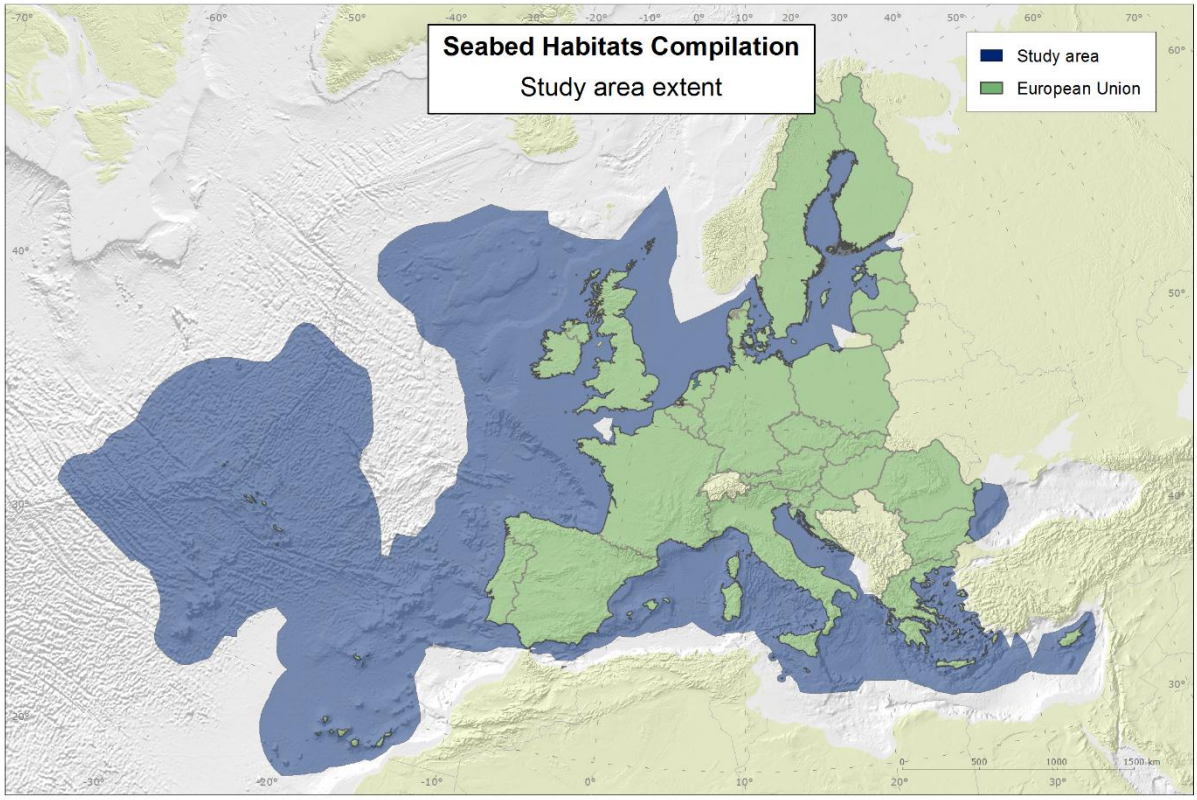

Figure 1: Spatial extent of the Study Area targeted by the EUNIS Seabed Habitat Compilation. See Legal Notice.

2.2 Geospatial sources

EUNIS-compliant information on Seabed Habitats is made publically-available through the EMODnet Seabed Habitats portal but covers only about half of the European Seas. Other separate world-wide seabed habitat mapping sources offer geospatial information that can be straightforwardly or, after some basic GIS processing, translated to EUNIS classes. This includes the UNEP's Global Seafloor Geomorphic Features Map which represents an adequate source of complementary information for some EUNIS habitats despite having been developed outside that scope.
The two sources of complementary geospatial information exploited in this work and the harmonization procedures used are detailed below.

2.2.1 EUSeaMap type coverage

EUNIS-compliant marine habitat maps are available through the EMODnet Seabed Habitats interactive map (http://www.emodnet-seabedhabitats.eu/default.aspx?page=1974). They use a nominal resolution of 250m and represent the best available surrogate for the distribution of marine benthic ecosystems throughout the European seas. With the due differences in terms of e.g. base data, survey techniques or temporal fusion of information, these data are the most comparable to the CORINE land cover maps for the marine environment.

The spatial coverage of the layers sourced from EMODNET (versions available on 6th October 2014) is shown in **Figure 2**. Overall, the data cover around 4.2 million km^2, corresponding to 47% of the Study Area. Some non-EUNIS seabed habitat classes present in the EMODNET datasets were maintained since they were related to marine ecosystem services by the reviewed literature and added some non-negligible coverage of the European seabed (blue areas in **Figure 2**).

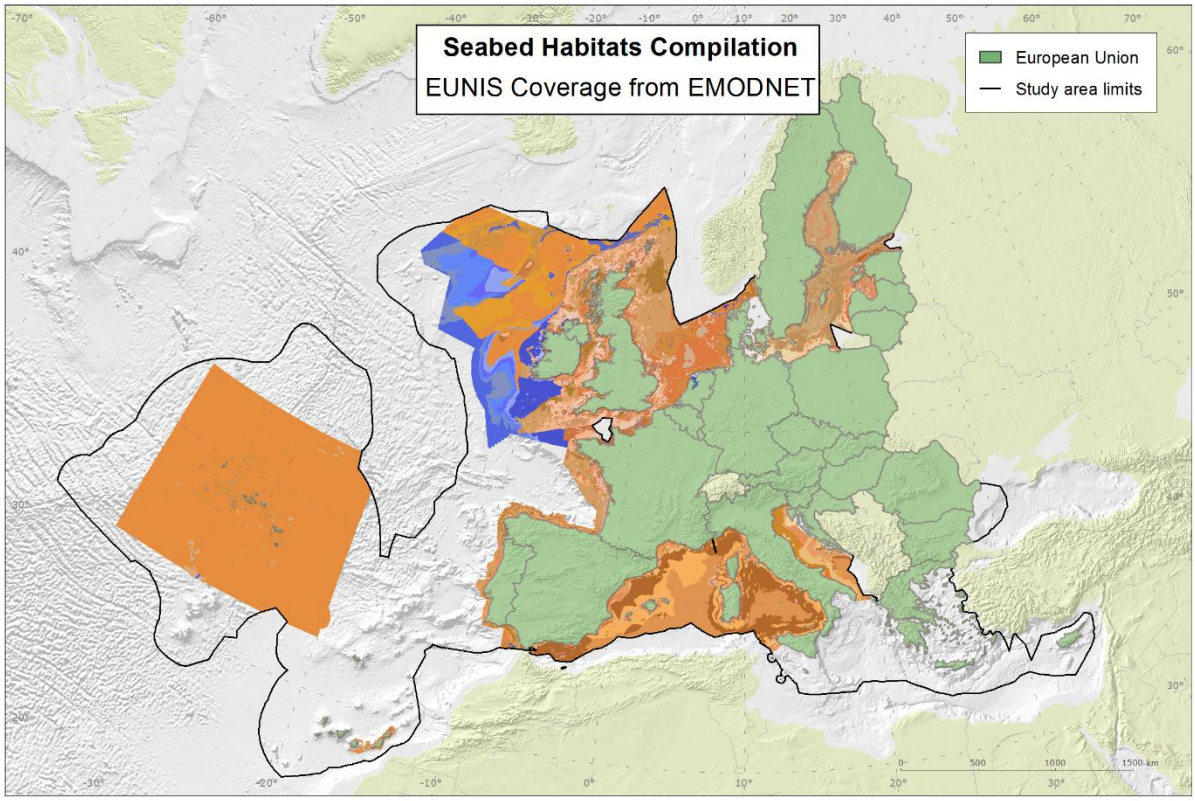

Figure 2: Spatial seabed habitat coverage derived from projects using the EUSeaMap approach. Areas in orange tones represent EUNIS-compliant seafloor habitat classes; areas in blue tones represent non-EUNIS seafloor habitat classes.

2.2.2 Global Seafloor Geomorphic Features Map

In order to achieve a most complete coverage of the study areas, the UNEP's Global Seafloor Geomorphic Features Map (GSGFM), available for download at http://www.bluehabitats.org/, was used as a complementary source of broad-scale marine habitat information. The GSGFM is the result of a collaboration between Conservation International, GRID-Arendal and Geoscience Australia. The seafloor geomorphic features mapped are derived from one or more of three generalised methods: 1) manual digitisation; 2) algorithm-assisted manual digitisation; and 3) algorithm digitisation with visual check (for details see Harris et al. 2014). GSGFM data used in this work were downloaded on 6th October 2014.

Despite not being produced under the scope of EUNIS, several geomorphic features in GSGFM can be straightforwardly translated to EUNIS classes (e.g., Seamounts, Canyons, Spreading Ridges, Fans, Trenches or Oceanic Island Flanks). Others, after some GIS operations, can also be used as good bases for EUNIS classes. For instance, GSGFM layers Spreading Ridges and Escarpments were altogether considered a good (though still underestimating) proxy for "A6.1: Deep-sea rock", while the GSGFM layer "Abyssal" plain was considered a proxy for "A6.5: Deep-sea mud". The GIS operations and direct translations applied to convert selected GSGFM information to EUNIS class layers are presented in **Table 1**.

Additionally, some non-EUNIS classes (e.g., upper slope, upper bathyal seabed, mid bathyal seabed, lower bathyal seabed) were produced by subdividing the GSGFM "Slope" class in depth strata (for details see **Table 2**). These classes were included in this exercise since they are related to marine ecosystem services in the reviewed literature. They provide coverage to parts of the Study Area that would otherwise be blank, namely portions of the Kattegat and Western Baltic, Bay of Biscay, Atlantic Iberia, Central and Eastern Mediterranean (blue areas in **Figure 3**).

Table 1: Layers sourced from UNEP's Global Seafloor Geomorphic Features Map (GSGFM) and GIS processing used to convert them into EUNIS classes.

GSGFM source layers	**GIS operation** (+ = merging; - = erasing)	**Resulting EUNIS class**
Spreading Ridge, Escarpments	Spreading Ridge + Escarpments assumed to represent a good surrogate for the broad-scale presence of deep-sea rock	**A6.1: Deep-sea rock and artificial hard substrata**
Slopes	Slope class truncated to areas around oceanic islands	**A6.71: Permanently submerged flanks of oceanic islands**
Seamounts, Ridges, Guyots, Escarpments, Spreading Ridges, Canyons, Shelves, Slopes	Seamounts + Ridges + Guyots – Canyons – Shelves – (continental)Slopes; fine editing of individual seamounts west of the UK and south of Cyprus (missing or poorly represented in GSGFM) based on EMODNET 2013 and ETOPO1 bathymetry; addition of Escarpments and Spreading Ridge sections associated to seamount-like structures	**A6.72: Seamounts, knolls and banks**
Spreading Ridges	None. Straightforward translation.	**A6.73: Oceanic ridges**
Rift Valleys	None. Straightforward translation.	**A6.732: Communities of ridge axial trough (i.e. non-vent fauna)**
Abyssal hills, Abyssal Mountains, A6.72 (result from above operation), Troughs, Trenches, Escarpments, Spreading Ridges, Canyons, Fans	Abyssal hills + Abyssal Mountains – A6.72 (result from operation above) – Troughs – Trenches – Escarpments – Spreading Ridges – Canyons – Fans	**A6.74: Abyssal Hills**
Canyons	None. Straightforward translation.	**A6.81: Canyons, channels, slope failures and slumps on the continental slope**
Fans	None. Straightforward translation.	**A6.814: Turbidites and fans**
Trenches, Troughs	Trenches + Troughs	**A6.82: Deep-sea trenches**
Abyssal plain	None. Straightforward translation.	**A6.5: Deep-sea mud**

Table 2: Layers sourced from UNEP's Global Seafloor Geomorphic Features Map (GSGFM) and the GIS processing employed to convert them into complementary (non-EUNIS) seabed habitat classes.

GSGFM source layers	**GIS operation** (+ = merging; - = erasing)	**Resulting seabed habitat class**
Slopes; EMODNET and ETOPO1 bathymetry where EMODNET not available	Slope subdivided in depth strata bands using EMODNET 2013 or ETOPO1 bathymetry. Upper slope: 200-750m depth	**Upper slope seabed**. Non-EUNIS seafloor habitat class related to specific ecosystem services in Galparsoro et al. (2014).
Slopes; EMODNET and ETOPO1 bathymetry where EMODNET not available	Slope subdivided in depth strata bands using EMODNET 2013 or ETOPO1 bathymetry. Upper slope: 750m-1100m depth	**Upper bathyal seabed**. Non-EUNIS seafloor habitat class related to specific ecosystem services in Galparsoro et al. (2014).
Slopes; EMODNET and ETOPO1 bathymetry where EMODNET not available	Slope subdivided in depth strata bands using EMODNET or ETOPO1 bathymetry. Mid slope: 1100-1800m depth	**Mid bathyal seabed**. Non-EUNIS seafloor habitat class related to specific ecosystem services in Galparsoro et al. (2014).
Slopes; EMODNET and ETOPO1 bathymetry where EMODNET not available	Slope subdivided in depth strata bands using EMODNET or ETOPO1 bathymetry. Lower slope: 1800m-4000m depth	**Lower bathyal seabed**. Non-EUNIS seafloor habitat class related to specific ecosystem services in Galparsoro et al. (2014).
Shelves	Clipped to shelf gap left uncovered by the existing EUSeaMap-type information.	**Shelf seabed**. Important gap-filler. Ecosystem services to be attributed based on ecosystem services commonly provided by the subordinate shelf habitats.

The spatial coverage of the information derived from GSGFM is shown in **Figure 3**. Overall the EUNIS-compliant data (orange-coloured polygons) cover 6,541,774 km^2 corresponding to 73% of the Study Area. These data were particularly useful to fill the gaps in the areas not yet addressed by EUSeaMap-type efforts in the Study area, namely the Western Mediterranean and wider Northeast Atlantic areas.

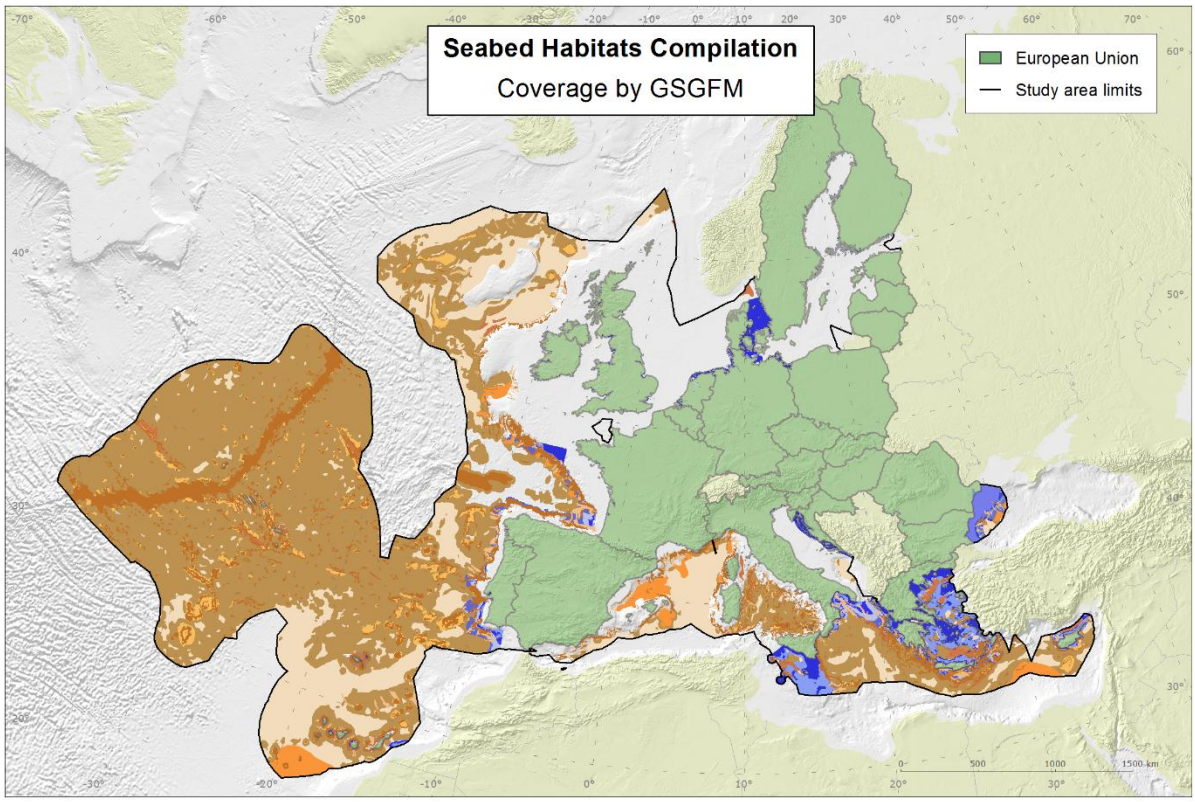

Figure 3: Spatial seabed habitat coverage derived from the UNEP's Global Seafloor Geomorphic Features Map. Areas in orange tones represent EUNIS-compliant seafloor habitat classes, while areas in blue tones represent non-EUNIS ones.

3. Results

3.1 Final compilation coverage

The seafloor habitat compilation obtained by aggregation of the two sources of information covered approximately 8.7 million km^2, corresponding to 96.4% of the Study Area (**Table 3**). This represents an increase of 105% (or 4.4 million km^2) in the EUNIS coverage of the Study Area, compared to the datasets presently available from the EMODNET Seabed Habitats portal. The new compilation achieves a percentage coverage above 90% at both EUNIS level 2 and 3 and a noteworthy coverage of 74% at EUNIS level 4 (**Table 3**). In terms of the proportion of classes mapped throughout the different EUNIS levels, the percentage decreases from 100% at EUNIS level 2 (i.e., 4 out of 4 possible classes present in the compilation), to 80% at level 3 (24 out of 30), 43% at level 4 (43 out of 99) and 2% at level 5 (7 out of 402 classes). No coverage was available for any classes at EUNIS level 6 or 7. The spatial distribution of the finest EUNIS hierarchical level achieved is presented in **Figure 4**.

Table 3. Coverage at the different EUNIS hierarchical levels (HL) achieved by the new compilation in comparison with the existing EMODNET Seabed Habitats datasets.

EUNIS Hierarchical Level	EUNIS classes mapped in the Study Area*	Extent mapped by EMODNET (km^2)**	Extent mapped by this study (km^2)**
EUNIS Level 2	**4** out of 4 (100%)	4,232,627 (47%)	8,676,685 (96.4%)
EUNIS Level 3	**24** out of 30 (80%)	4,230,262 (47%)	8,304,585 (92.3%)
EUNIS Level 4	**43** out of 99 (43%)	1,963,920 (22%)	6,640,584 (73.8%)
EUNIS Level 5	**7** out of 402 (2%)	2,365 (0.03%)	305,035 (3.4%)
EUNIS Level 6	**0** out of 112	-	-
EUNIS Level 7	**0** out of 4	-	-
Non-EUNIS complementary classes	**21**	489,874 (5.4%)	932,274 (10.4%)
		Study area total area:	8,996,398 km^2

*percentage of the total number of permanently-submerged seabed habitat classes in version 2007 of the EUNIS classification given in brackets; ** percentage cover of the Study Area given in brackets.

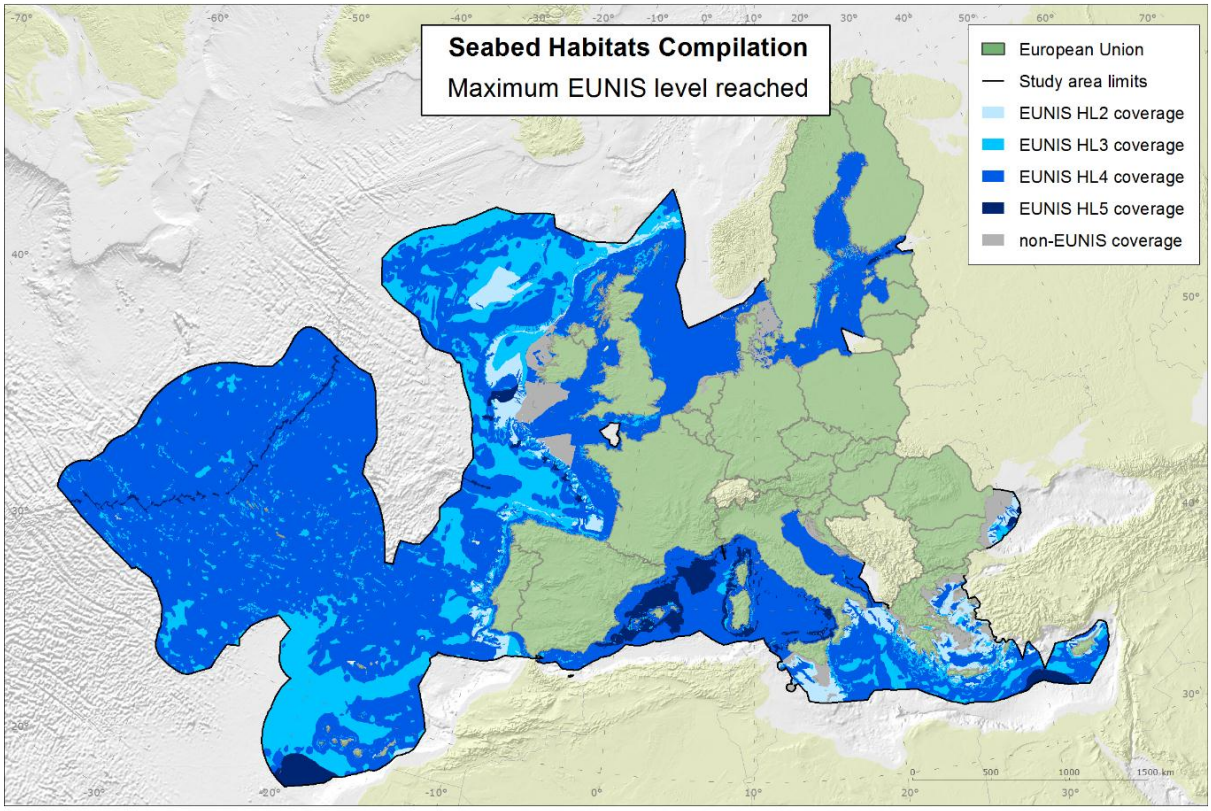

Figure 4: Spatial distribution of the maximum EUNIS level achieved by the seabed habitat compilation.

3.2 Final EUNIS Seabed Habitat Map

Overall, 69 different EUNIS seabed habitat classes are present in the final compilation. A list of these classes is provided in **Table 4** (EUNIS habitats) and **Table 5** (non-EUNIS habitats) including their mapped extent in the study area and per basin. The distribution of the EUNIS classes mapped throughout the different hierarchical levels of EUNIS is shown in **Figures 5 to 9**. The integration of this dataset in the MARATLAS portal (http://ec.europa.eu/maritimeaffairs/atlas/maritime_atlas/) is currently under consideration.

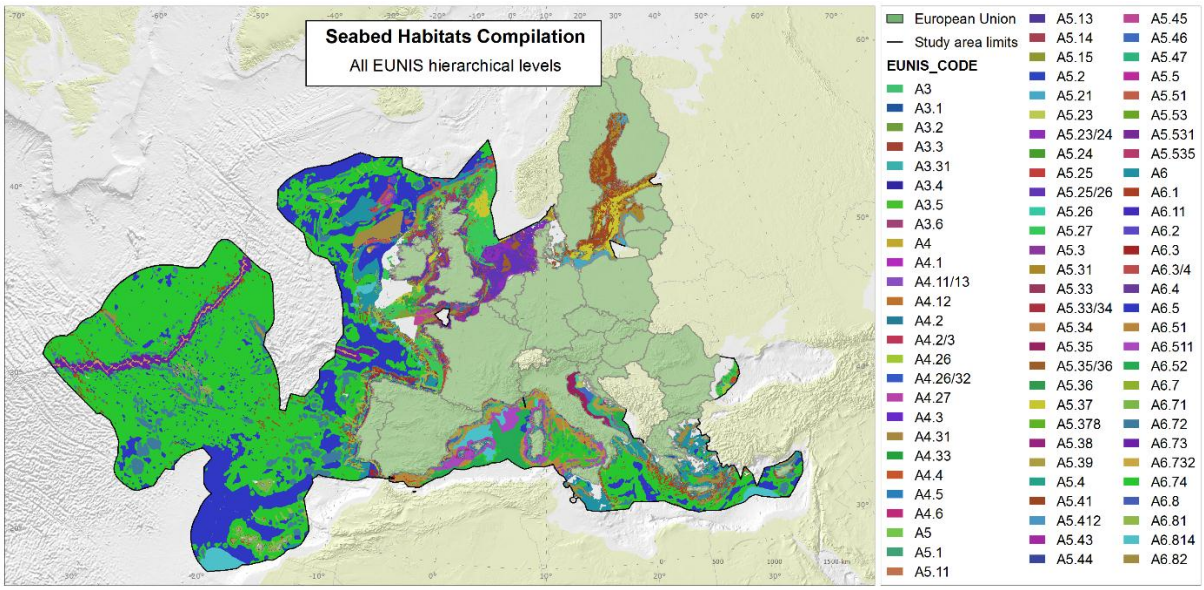

Figure 5: Spatial distribution of the EUNIS seabed habitat classes in the new compilation. A. Mosaic of all EUNIS classes. For an interpretation of the habitat codes see Table 3.

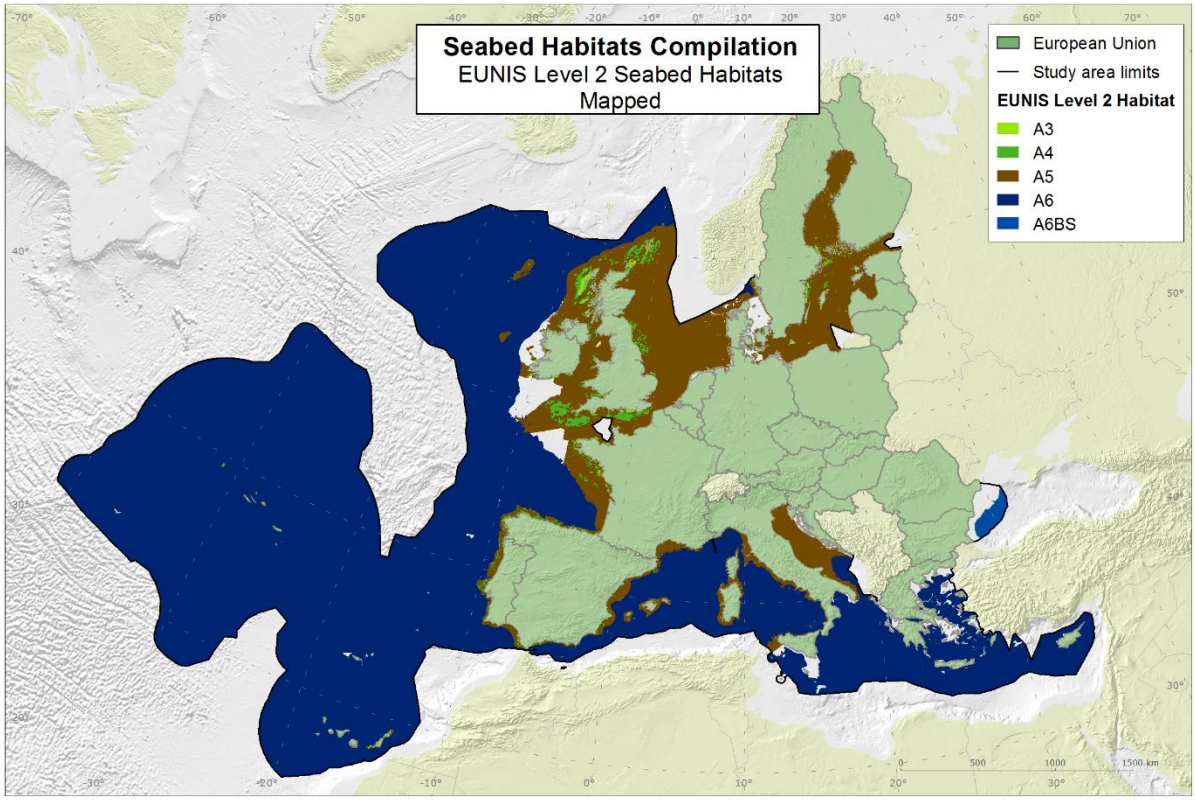

Figure 6: Spatial distribution of the EUNIS seabed habitat level 2 classes in the new compilation. For an interpretation of the habitat codes see Table 3.

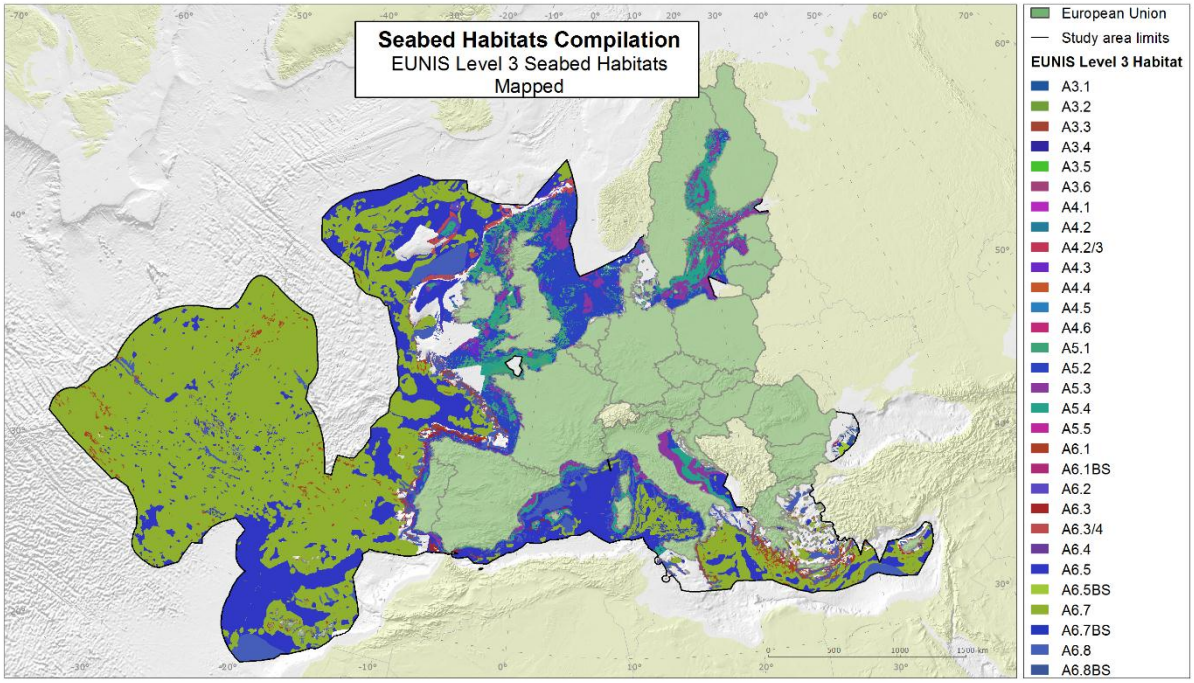

Figure 7: Spatial distribution of the EUNIS seabed habitat level 3 classes in the new compilation. For an interpretation of the habitat codes see Table 3.

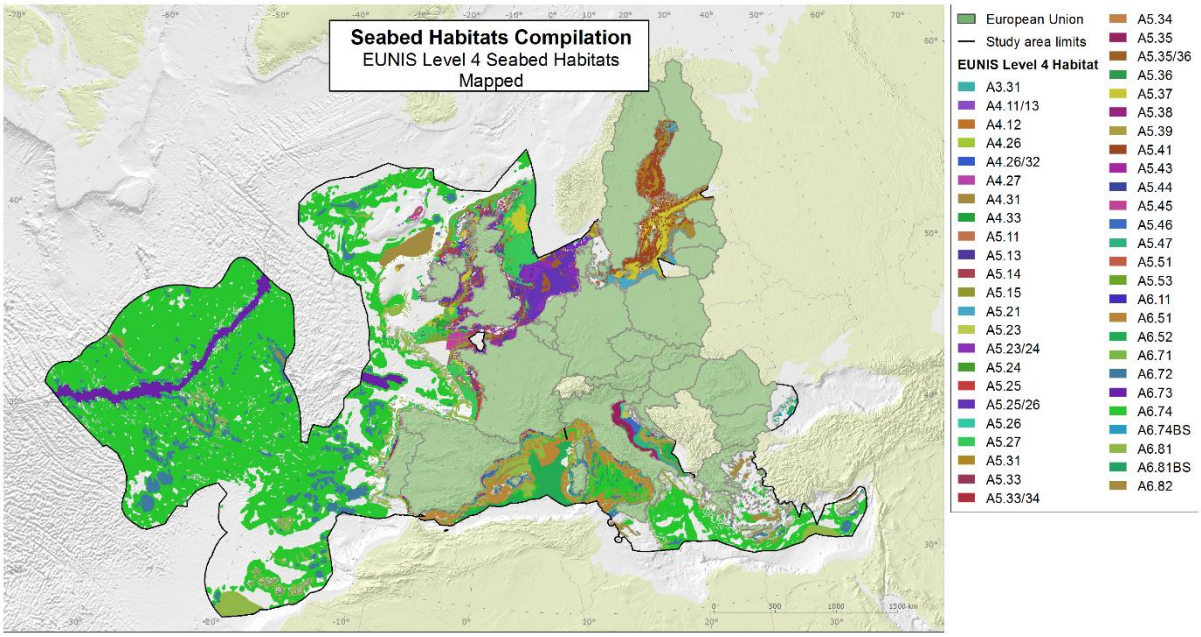

Figure 8: Spatial distribution of the EUNIS seabed habitat level 4 classes in the new compilation. For an interpretation of the habitat codes see Table 3.

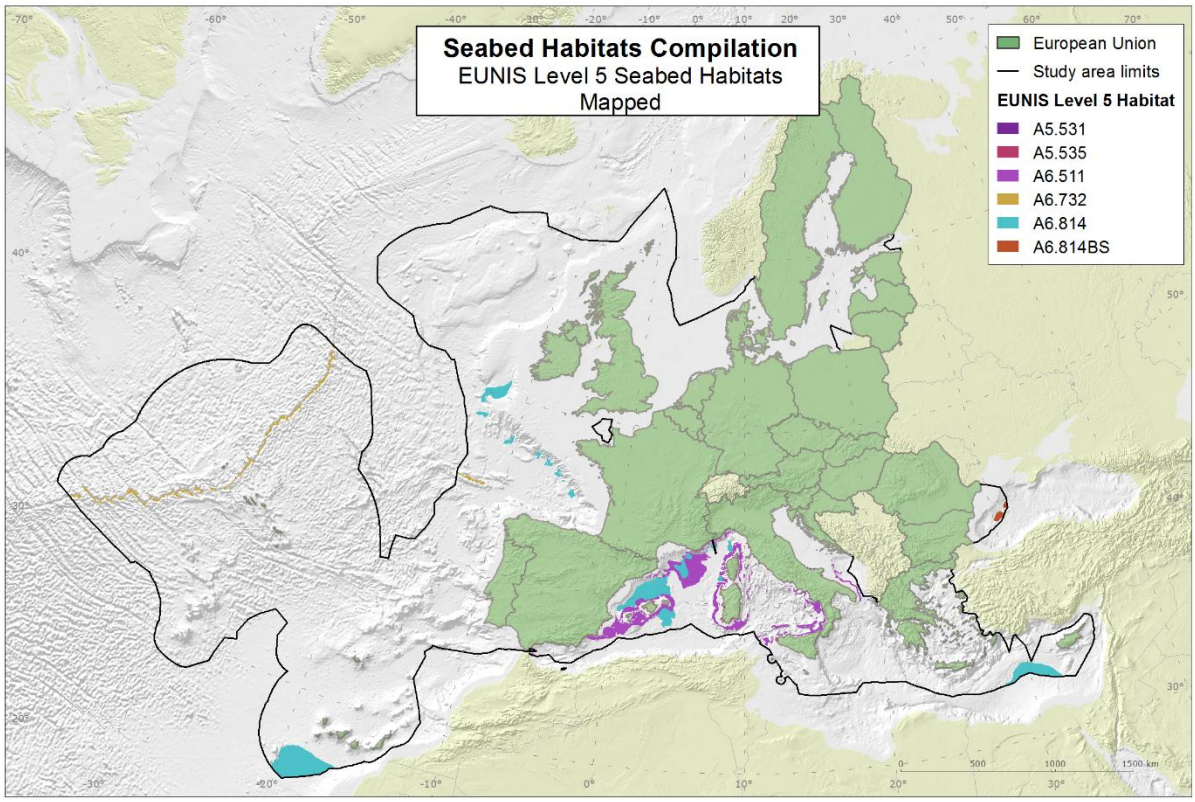

Figure 9: Spatial distribution of the EUNIS seabed habitat level 5 classes in the new compilation. For an interpretation of the habitat codes see Table 3.

The presence of habitats from GSGFM and EUSeaMap-type projects was not used in a mutually-exclusive manner. Overlapping information (i.e., polygons) originating from the two sources were kept where information from GSGFM layers enhanced that of the layers derived from EUSeaMap-type projects and could improve the mapping of marine ecosystem services. The same approach was followed throughout the extent of the non-EUNIS classes which fill some gaps and provide an enhanced proxy for mapping ecosystem services.

Table 4: List of the EUNIS seabed habitats present in the final compilation with the respective coverage in the study area and per basin.

Note that, expectedly, the mapped extents of several habitats are biased and underestimated, as EUSeaMap-type efforts have not yet comprehensively and equally covered all EU waters. Thus they should be interpreted as minimum estimates. Most notoriously underestimated extents are marked with an asterisk (*).

	Mapped areas (km2) and % of habitat total (in grey)								
EUNIS Seabed Habitats	Total (km2)	Baltic	%	Atlantic	%	Medit.	%	Black Sea	%
A3: Infralittoral rock and other hard substrata	24,578*	4,515	18	18,851	77	1,212*	5	*	
A3.1: Atlantic and Mediterranean high energy infralittoral rock	10,795*	-		10,795	100	*		-	
A3.2: Atlantic and Mediterranean moderate energy infralittoral rock	5,906*	-		5,906	100	*		-	
A3.3: Atlantic and Mediterranean low energy infralittoral rock	1,411*	-		1,411	100	*		-	
A3.31: Silted kelp on low energy infralittoral rock with full salinity	966	-		966	100			-	
A3.4: Baltic exposed infralittoral rock	993	993	100	-		-		-	
A3.5: Baltic moderately exposed infralittoral rock	2,494	2,494	100	-		-		-	
A3.6: Baltic sheltered infralittoral rock	1,027	1,027	100	-		-		-	
A4: Circalittoral rock and other hard substrata	82,080*	5,271	6	74,712	91	2,097*	3	*	
A4.1: Atlantic and Mediterranean high energy circalittoral rock	6,283	-		6,283	100			-	
A4.11/13: Circalittoral rock (doubt between A4.11 and A4.13)	4,121	-		4,121	100			-	
A4.12: Sponge communities on deep circalittoral rock	246	-		246	100			-	
A4.2: Atlantic and Mediterranean moderate energy circalittoral rock	42,023*	-		40,035	95	1,988*	5	-	
A4.2/3: Atlantic and Mediterranean circalittoral rock (doubt between A4.2 and A4.3)	108*	-				108*	100	-	
A4.26: Mediterranean coralligenous communities moderately exposed to hydrodynamic action	1,243*	-		-		1,243*	100	-	
A4.26/32: Mediterranean coralligenous communities (doubt between A4.26 and A4.32)	108*	-		-		108*	100	-	
A4.27: Faunal communities on deep moderate energy circalittoral rock	13,953*	-		13,209	95	744*	5	-	
A4.3: Atlantic and Mediterranean low energy circalittoral rock	27,982	-		27,982	100			-	
A4.31: Brachiopod and ascidian communities on circalittoral rock	2,100	-		2,100	100			-	
A4.33: Faunal communities on deep low energy circalittoral rock	18,594	-		18,594	100			-	
A4.4: Baltic exposed circalittoral rock	2,465	2,465	100	-		-		-	
A4.5: Baltic moderately exposed circalittoral rock	1,721	1,721	100	-		-		-	
A4.6: Baltic sheltered circalittoral rock	1,086	1,086	100	-		-		-	
A5: Sublittoral sediment	1,361,186*	341,493	25	832,936	61	186,756*	14	*	
A5.1: Sublittoral coarse sediment	212,984*	12,735	6	199,366	94	883*	0.4	*	
A5.11: Infralittoral coarse sediment in low or reduced salinity	12,114*	12,114	100	*		*		*	
A5.13: Infralittoral coarse sediment	27,979*			27,113	97	866*	3		
A5.14: Circalittoral coarse sediment	84,593*			84,576	100	17*	0.02		
A5.15: Deep circalittoral coarse sediment	87,676*			87,676	100	*			
A5.2: Sublittoral sand	542,931*	48,581	9	479,088	88	15,262*	3	*	
A5.21: Sublittoral sand in low or reduced salinity	48,581*	48,581	100			*		*	
A5.23: Infralittoral fine sand	17,360*			5,176*	30	12,184*	70		
A5.23/24: Infralittoral sand (doubt between A5.23 and A5.24)	65,889			65,889	100				
A5.24: Infralittoral muddy sand	661*			661*	100	0.3*	0.04		
A5.25: Circalittoral fine sand	11,162*			10,997*	99	165*	1		
A5.25/26: Circalittoral sand (doubt between A5.25 and A5.26)	138,285			138,285	100				
A5.26: Circalittoral muddy sand	5,766*			2,853*	49	2,913*	51		
A5.27: Deep circalittoral sand	255,226			255,226	100				
A5.3: Sublittoral mud	313,243*	140,572	45	99,213	32	73,457*	23	*	
A5.31: Sublittoral mud in low or reduced salinity	79,645*	79,645	100					*	
A5.33: Infralittoral sandy mud	2,245*			354*	16	1,891*	84		
A5.33/34: Infralittoral mud (doubt between A5.33 and A5.34)	4,467			4,467	100				
A5.34: Infralittoral fine mud	1,721*			710*	41	1,011*	59		
A5.35: Circalittoral sandy mud	25,855*			1,082*	4	24,773*	96		
A5.35/36: Circalittoral mud (doubt between A5.35 and A5.36)	24,882			24,882	100				
A5.36: Circalittoral fine mud	4,119*			2,902*	70	1,217*	30		
A5.37: Deep circalittoral mud	125,743*	60,927	48	64,816*	52				
A5.378: Baltic muddy bottoms of the aphotic zone	2,989	2,989	100	-		-		-	
A5.38: Mediterranean communities of muddy detritic bottoms	11,030*	-		-		11,030*	100	-	
A5.39: Mediterranean communities of coastal terrigenous muds	33,535*	-		-		33,535*	100	-	
A5.4: Sublittoral mixed sediments	286,325*	139,604	49	55,269*	19	91,451*	32	*	
A5.41: Sublittoral mixed sediment in low or reduced salinity	139,604	139,604	100					*	
A5.412: Baltic mixed sediment bottoms of the aphotic zone	110	110	100	-		-		-	
A5.43: Infralittoral mixed sediments	8,327*			8,327*	100				
A5.44: Circalittoral mixed sediments	15,885*			15,885*	100				
A5.45: Deep circalittoral mixed sediments	31,057*			31,057*	100				
A5.46: Mediterranean animal communities of coastal detritic bottoms	35,884*	-		-		35,884*	100	-	
A5.47: Mediterranean communities of shelf-edge detritic bottoms	55,567*	-		-		55,567*	100	-	
A5.5: Sublittoral macrophyte-dominated sediment	5,703*	*		*		5,703*	100		
A5.51: Maerl beds	86*			*		86*	100		
A5.53: Sublittoral seagrass beds	5,616*	*		*		5,616*	100		
A5.531: [Cymodocea] beds	634*			*		634*	100	-	
A5.535: [Posidonia] beds	4,982*	-		-		4,982*	100	-	
A6: Deep-sea bed	7,214,595	*		5,892,183	82	1,292,517	18	29,895	0.4
A6.1: Deep-sea rock and artificial hard substrata	790,653			606,700	77	183,048	23	905	0.1
A6.11: Deep-sea bedrock	6,814*			6,814*	100	*			
A6.2: Deep-sea mixed substrata	102,915*			100,303*	97	2,611*	3		
A6.3: Deep-sea sand	37,627*			28,938*	77	8,689*	23		
A6.3/4: Deep-sea sand (doubt between A6.3 and A6.4)	154,433			154,433	100				
A6.4: Deep-sea muddy sand	19,117*			6,933*	36	12,184*	64		
A6.5: Deep-sea mud	3,510,615*			2,850,215	81	653,406*	19	6,994	0.2
A6.51: Mediterranean communities of bathyal muds	358,911*	-		-		358,911*	100	-	
A6.511: Facies of sandy muds with [Thenea muricata]	139,782*	-		-		139,782*	100	-	
A6.52: Communities of abyssal muds	196,413*	-		*		196,413*	100		
A6.7: Raised features of the deep-sea bed	4,422,960	-		4,010,616	91	410,344	9	2,000	0.05
A6.71: Permanently submerged flanks of oceanic islands	49,117	-		45,680	93	3,437	7	-	
A6.72: Seamounts, knolls and banks	472,035	-		437,626	93	34,409	7	-	
A6.73: Oceanic ridges	175,001	-		175,001	100	-		-	
A6.732: Communities of ridge axial trough (i.e. non-vent fauna)	29,092	-		29,092	100	-		-	
A6.74: Abyssal hills	3,808,019	-		3,433,003	90	373,016	10	2,000	0.1
A6.8: Deep-sea trenches and canyons, channels, slope failures and slumps on the continental slope	484,071	-		268,323	55	208,026	43	7,722	2
A6.81: Canyons, channels, slope failures and slumps on the continental slope	351,998	-		186,567	53	157,709	45	7,722	2
A6.814: Turbidites and fans	149,780	-		75,314	50	70,888	47	3,579	2
A6.82: Deep-sea trenches	145,172	-		81,888	56	63,284	44	-	

Table 5. List of the non-EUNIS seabed habitats present in the final compilation with the respective coverage in the study area and per basin.

Note that these non-compliant habitats are mainly used to cover gaps remaining in the EUNIS-harmonized coverage; their extents are not mapped systematically throughout the European Seas and are provided for the sake of completeness.

		Absolute areas (km2) and % of total in grey							
NON-EUNIS gap-filling seabed habitat	Total (km2)	Baltic	%	Atlantic	%	Medit.	%	Black Sea	%
N_1: Abyssal seabed	94,799			94,799	100				
N_2: Deep-circalittoral mixed hard sediments	28			28	100				
N_3: Deep-circalittoral seabed	89,521			89,521	100				
N_4: Deep-sea coarse sediment	33,060			33,060	100				
N_5: High-energy circalittoral mixed hard sediments	119			119	100				
N_6: High-energy circalittoral seabed	724			724	100				
N_7: High-energy infralittoral mixed hard sediments	497			497	100				
N_8: High-energy infralittoral seabed	6,362			6,362	100				
N_9: Low-energy circalittoral mixed hard sediments	12			12	100				
N_10: Low-energy circalittoral seabed	843			843	100				
N_11: Low-energy infralittoral mixed hard sediments	20			20	100				
N_12: Low-energy infralittoral seabed	213			213	100				
N_13: Lower-bathyal coarse sediment	485			485	100				
N_14: Lower-bathyal seabed	111,059			102,850	93	8,208	7		
N_15: Mid-bathyal coarse sediment	326			326	100				
N_16: Mid-bathyal seabed	130,288			113,482	87	16,806	13		
N_17: Moderate-energy circalittoral mixed hard sediments	1,139			1,139	100				
N_18: Moderate-energy circalittoral seabed	5,474			5,474	100				
N_19: Moderate-energy infralittoral mixed hard sediments	322			322	100				
N_20: Moderate-energy infralittoral seabed	544			544	100				
N_21: Upper-bathyal coarse sediment	281			281	100				
N_22: Upper-bathyal seabed	58,658			42,327	72	16,331	28		
N_23: Upper-slope mixed hard sediments	789			789	100				
N_24: Upper-slope seabed	172,793			53,726	31	119,067	69		
N_25: Black Sea shelf seabed	34,986	-		-		-		34,986	100
N_26: Black Sea upper-slope seabed (anoxic)	3,733	-		-		-		3,733	100
N_27: Black Sea upper-bathyal seabed (anoxic)	2,443	-		-		-		2,443	100
N_28: Black Sea mid-bathyal seabed (anoxic)	7,324	-		-		-		7,324	100
N_29: Black Sea lower-bathyal seabed (anoxic)	708	-		-		-		708	100
N_30: Shelf seabed	176,038	38,345	22	28,670	16	109,023	62		

4. Final remarks

The seafloor habitat compilation obtained by aggregation of the two sources of information resulted in a polygon shapefile comprising approximately 8.7 million km^2 and covering more than 90% of the EU Seas, independently of the administrative segmentation we use. These numbers more than double the coverage of EUNIS seabed habitat classes when compared to the datasets currently available from the EMODNET Seabed Habitats portal.

Given that EUSeaMap-type efforts have not yet comprehensively and equally covered all EU waters, it is worth-noting in terms of information accuracy, that the mapped extents of several habitats are still geographically biased and underestimated in relation to their actual extent. The quantified and mapped habitat extents should therefore be interpreted as minimum estimates until the ongoing project EMODnet Seabed Habitats, also known as EUSeaMap 2, produces a EUNIS-compliant coverage of the eastern Mediterranean, the Black Sea and part of the Macaronesia and parts of the Celtic Seas. This is expected to happen by 2016.

Despite no valuable information was brought in concerning EUNIS shelf habitats, the information sourced from GSGFM detailed a series of geomorphic-based EUNIS habitat classes throughout a large part of the EU Seas that was previously uncharted in terms of habitats, namely deep-sea ones. For this reason, the new geospatial dataset produced represents a comprehensive and valuable basis for assessing the distribution of many EUNIS seabed habitat classes in EU waters and conducting area-based assessments of, for instance, seabed-related Uses, Functions and Services. The latter will be addressed in a forthcoming dedicated report.

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