



EMODnet



European Marine
Observation and
Data Network

EMODnet Thematic Lot n° 2 – Seabed Habitats

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Executive summary

This Final Report summarises the progress over the two-year period of the latest phase of the EMODnet Lot 2 Seabed Habitats project and concludes this phase of the project under the current consortium.

The data preparation work package (WP1) produced several new environmental data layers. This included extending the light at the seabed data product to include the Barents Sea and Iceland, and using inputs from Copernicus Marine Environmental Monitoring Service, EMODnet Bathymetry and Geology to predict oceanographic variables at the seabed, such as kinetic energy, temperature and oxygen. These data products are now published on the EMODnet Seabed Habitats portal, freely available to anybody who wishes to model biodiversity at a regional scale.

Using the WP1 outputs, we produced an updated base layer of modelled habitats for all sea basins in Europe (called EUSeaMap) (WP2). It is classified according to EUNIS, MSFD benthic broad habitat and a bespoke classification based on EUNIS but adds more details where possible and relevant. Since phase 2, the coverage has increased to include the Barents Sea and any area of seabed that is covered by the EMODnet Bathymetry DTM and EMODnet Geology substrate layer. The resolution has also increased, now with a cell size of 100m. A suite of easy-to-understand confidence layers give a simple high/moderate/low confidence representation for each input layer and for each habitat classification. Producing a 100m resolution model for the entire European seabed is an extremely data-intensive task. We have redeveloped the method using scripting and carrying out certain stages of the processing using vector data instead of raster data to maintain the detail.

Building on the successful data submission process we established for habitat maps, in this phase we also directed our efforts towards compiling a library of models that predict the likelihood of presence of habitats (WP3). There is now a compilation of 54 models available to view on the portal; while an in-depth review identified over 200 seabed habitat modelling studies in Europe.

For the first time ever, the consortium has produced a Europe-wide compilation of habitat observations from ground-truthing surveys (WP4). Firstly, we created a standard data schema that allowed data from multiple sources to be combined. We worked with EMODnet Biology to ensure this schema was compatible with that used for species observations (Darwin Core) so that in the near future it will be possible to submit the data directly to the same repository (OBIS) – we have initiated this process with a pilot project using data from the UK. The consortium has, to date, submitted >300,000 ground truthing points, which are now freely available via the portal.

Continuing the compilation of habitat maps from survey (WP5) that began in phase 2, we gathered an additional 257 habitat maps in Year 1 and 167 in Year 2, which are now available on the portal. As the library of habitat maps from surveys grows, we have recognised the opportunity to use this collection to make new data products that may be useful at regional/international scales. Therefore, we have trialled an approach to building composite products using the library of habitat maps available on the EMODnet Seabed Habitats portal. We created products showing the known extent of three 'essential ocean variables': seagrass meadows, live hard coral and macroalgal canopy cover.

In Year 1, the EMODnet web portal (WP6) was relaunched to conform with the updated EMODnet Style Guide and a new back-end system for the interactive map was implemented in the form of GeoServer which has improved functionality for machine-to-machine web services. In Year 2 we launched a fresh new front-end for the portal's map viewer that is more user-friendly and has additional functionality, including the ability to control layer transparency and layer order and to view individual legends.

We have continued to work closely with other Lots, including having a representative from Bathymetry at one of our progress meetings to discuss confidence assessment, multiple Skype and face-to-face meetings with Biology to discuss data schemas and essential ocean variables products, and liaison with Geology regarding seabed substrate. We have continued to reach out to stakeholders to gather requirements and promote the outputs of the project. This included taking part in the stakeholder workshops organised by the Biology Lot (as the stakeholders are very similar) and having individual conversations with relevant representatives from

the regional sea conventions. We have learnt many lessons throughout the course of this project and have listed some recommendations for follow-up actions by the EU.

1 Introduction

The EMODnet Seabed Habitats project brings together a consortium of 12 partners which cover the full geographic scope of the project area:

- The Black Sea is represented by GeoEcoMar and IO-BAS.
- The Eastern Mediterranean is represented by ISPRA and HCMR.
- The Western Mediterranean is represented by Ifremer and ISPRA.
- The Atlantic basins are represented by the Marine Institute, JNCC, CCMAR and Ifremer.
- The Arctic basins, Greater North Sea and Norwegian Sea are represented by NIVA, JNCC, GEUS and Bioconsult.
- The Baltic is represented by GEUS, SYKE and Bioconsult.

The first consistent broad-scale seabed habitat maps for European waters were developed under the Preparatory action for EMODnet (EC contract no. MARE/2008/07) supporting the European Commission's vision for *"a seamless multi-resolution digital seabed map of European waters by 2020"*. Phase 2 of the EMODnet Seabed Habitats project (EC contract no. MARE/2012/10) extended these prototype maps so that they now cover all European basins, building on the methodology with enhanced validation. This broad-scale product has been complemented with a collation of habitat maps from surveys that are freely disseminated online through the same portal. Phase 3 of EMODnet Seabed Habitats has fulfilled the desire to deliver products to the highest resolution possible, by changing our modelling methods to take account of the best-resolution data coming from other lots (for example, Lot 1 Geology), compiling a database of ground truthing data and boosting the existing library of digital habitat maps. To provide our data and data products to users in the most efficient and helpful way, we have made improvements to our portal so that the user experience is the best it can be, maximising interoperability and ensuring data are freely available.

The tender specification called for eight tasks to be undertaken by the consortium:

- Task 1: Develop a common method of access to data held in repositories
- Task 2: Construct products from one or more data sources that provide users with information about the distribution of parameters in time and space
- Task 3: Develop procedures for machine-to-machine connections to data and data products
- Task 4: Develop a web portal allowing users to find, visualise and download data
- Task 5: Ensure the involvement of regional sea conventions
- Task 6: Facilitate interoperability with data distributed by non-EU organisations
- Task 7: Install a process to monitor performance and deal with user feedback
- Task 8: Operate a help desk offering support to users

These tasks were delivered through seven work packages:

WP1: Data preparation

For “a base layer of modelled habitat at a scale of 1:100,000 or better” we need input data representing the most important abiotic variables for predicting these habitats. These input data need to be at a resolution that is sufficient to describe the resolution at which these abiotic variables vary in nature. This work package ensured that we had the best possible input data layers to feed into WP2.

WP2: Thresholds, modelling and confidence for broad-scale physical habitat map

This work package constructed an updated broad-scale habitat map for all European sea basins (known as EUSeaMap) and an accompanying confidence map.

WP3: Individual habitat modelling

The main objective of this work package was to explore how modelling of single habitats can be integrated with the results of broad-scale modelling, and therefore contribute to our ‘map of the sea’. Additional objectives were to carry out a review of individual seabed habitat modelling, to collate and disseminate existing modelled maps of seabed habitats through our portal.

WP4: Ground truthing data

This work package collated and provided access to ground truthing information showing the spatial distribution of habitats and communities in European marine waters.

WP5: Library of habitat maps

This work package built on our previous work to build a comprehensive “library of digital habitat maps from national and regional collections as well as from completed EU projects. Where feasible, collections shall be combined and harmonised into single layers”. This library is available to download from the EMODnet Seabed Habitats portal.

WP6: Portal and EUNIS application

The objective of this work package was to provide an attractive, intuitive means for the public to discover, view and download data and data products used, created and collated by the Project. The work package built and improved on the existing EMODnet Seabed Habitats portal framework to provide both front-facing user-interfaces and OGC/INSPIRE compliant machine-to-machine web services for integration into other platforms and websites.

WP7: Co-ordination and communication

The objective of this work package was to co-ordinate the scientific and technical achievements of the Partnership, to manage the Project in terms of deliverables, deadlines, budget and financial matters and to organise communication and dissemination.

2 Highlights in this reporting period

- **A new broad-scale seabed habitat map for Europe: EUSeaMap 2019**

A new version of the full coverage broad-scale habitat map has been produced (developing new thresholds where relevant) and published via the EMODnet Seabed Habitats portal with extended geographic range up into the Barents Sea.

- **A suite of environmental data products for multiple applications**

EUSeaMap required regional-scale data products on ecologically-relevant environmental variables at the seabed. Where these didn't exist we created new ones, included light availability, kinetic energy due to waves and currents, and temperature. These are now freely available for others to use in predictive habitat modelling and other applications.

- **Europe's first compilation of habitat observations from ground truthing surveys**

During this phase we have compiled the first Europe-wide collation of seabed habitat point samples and have collated and published over 300,000 point samples from across Europe.

- **Compilation of habitat maps from surveys continues to grow**

An additional 424 habitat maps have been collated from across Europe in the second year of the project bringing the total number of habitat maps available on the portal to over 850.

- **Europe's first compilation of predictive habitat models**

54 predictive habitat models ranging from local to regional scale have been collated and published via the EMODnet Seabed Habitats portal.

- **New composite data products for three essential ocean variables**

For the first time the habitat maps collated by EMODnet Seabed Habitats have been used to create new data products with the piloting of the creation of three Europe-wide layers of the [Global Ocean Observing System Essential Ocean Variables](#) (EOVs) – extent of seagrass meadows, macroalgal canopy and live hard coral cover. These layers were created by identifying which habitats were correlated with the definitions of the EOVs and then extracting the corresponding polygons from the collated habitat maps.

- **Relaunch of portal and interactive map**

The website (www.emodnet-seabedhabitats.eu) was redesigned and recreated using a new, open-source content management system, Umbraco. The site was redesigned with careful consideration of the harmonisation requirements laid out by the EMODnet Secretariat. The map viewer (www.emodnet-seabedhabitats.eu/access-data/launch-map-viewer/) was completely overhauled. The back-end now runs using all open-source software: PostgreSQL (for storage of vector data), GeoServer (for managing the layers) and OpenLayers (for displaying the map layers). The front-end is now more user-friendly with additional features such as a gazetteer, layer transparency options and layer reordering capability.

3 Summary of the work done

An overview of wider progress against the work packages can be found in Section 6. A summary of progress in relation to the eight tasks specified in Section 1.4.1 of the Tender Specification is highlighted below:

Task 1: Develop a common method of access to data held in repositories

EMODnet Seabed Habitats has continued to collate and make available habitat maps from across European Seas. An additional 424 habitat maps, 54 single habitat models and 312,779 habitat data points have been brought together, standardised and made available on the EMODnet Seabed Habitats portal alongside the data products which we have created in house (EUSeaMap, models of environmental variables at the seabed (light, energy due to waves and currents, temperature, salinity and oxygen) and single habitat composite maps for seagrass, macroalgae and live coral) further extending our remit as a “one-stop shop” for habitat mapping data in Europe.

Task 2: Construct products from one or more data sources that provide users with information about the distribution of parameters in time and space

EUSeaMap 2019 with associated confidence layers has been updated and published via the EMODnet Seabed Habitats portal. This new version of the map has a higher resolution, uses improved input layers and has increased coverage since EUSeaMap 2016, now extending up into the Barents Sea.

We produced several new models showing the values of biologically-relevant environmental variables at the seabed. This includes kinetic energy at the seabed due to waves and currents in the Mediterranean, Black Sea and Atlantic, light at the seabed for all Europe (extended from phase 2 to include Barents Sea and Iceland) and density at the seabed in the Black Sea.

Three composite data layers for the [GOOS Essential Ocean Variables](#) seagrass, macroalgae and live coral have been collated by the extraction of the relevant data from the catalogue of individual habitat maps from survey available through EMODnet Seabed Habitats and made available via the EMODnet Seabed Habitats portal. They have also been sent to EMODnet Biology for incorporation into their Atlas of Marine Life.

Task 3: Develop procedures for machine-to-machine connections to data and data products

We have undertaken extensive work to facilitate the dissemination of seabed habitat data to end users. We have transferred the management of the interactive map’s layers over to GeoServer. This new platform allows for improved machine-to-machine connections through INSPIRE and Open Geospatial Consortium (OGC) compliant Web Mapping Services (WMS) and Web Feature Services (WFS) and additionally includes Web Coverage Services (WCS) as standard. A Python workflow has been developed to improve the spatial data infrastructure and automate data management within Seabed Habitats, utilising GeoServer’s application programming interface (API) and extensive RESTful services. Future development aims to harvest and publish metadata to online portals utilising machine-to-machine communication, improving the exposure of EMODnet Seabed Habitat and access to stakeholders.

Task 4: Develop a web portal allowing users to find, visualise and download data

The EMODnet Seabed Habitats web portal was been relaunched and now operates on the Umbraco Content Management System. It has been brought up-to-date and is now in line with the recently launched EMODnet Style Guide. We have added SSL certification to our website and GeoServer web services to make the portal fully secure and also relaunched the map viewer that sits within the EMODnet Seabed Habitats portal. The portal has also been updated with our newly created full coverage broadscale habitat map EUSeaMap 2019, new environmental data layers, an single habitat models, habitat data points and habitat maps.

Task 5: Ensure the involvement of regional sea conventions

We have continued good relations with OSPAR joining their meetings and feeding into discussions on how we can best support them through the provision of datasets they require for their reporting. We have also been in discussions with the OSPAR Secretariat on work they are doing to collate benthic datasets for the North-East Atlantic and how our EMODnet data could feed into this process. Discussions are still ongoing with RAC/SPA over developing an MoU to cover data sharing between their Mediterranean Biodiversity Platform and the EMODnet Seabed Habitats portal. We have tried to engage with HELCOM and the Black Sea Convention although our inroads have been more limited here.

Task 6: Facilitate interoperability with data distributed by non-EU organisations

The >310,000 ground-truthing data points that have been collated through WP4 are compliant with Darwin Core, facilitating interoperability with non-EU data. A database has been created in order to hold habitat point data in a Darwin Core compliant manner and we have run a pilot project to test the submission of habitat information to the global Ocean Biodiversity Information System (OBIS). The eventual aim is to submit all habitat point data to OBIS and it is planned that this work will progress in the next phase of EMODnet Seabed Habitats.

Work has continued to improve data consistency and European interoperability by implementing Europe's key habitat classification systems within online vocabularies: the OSPAR list of threatened and/or declining habitats and species (<http://vocab.nerc.ac.uk/collection/M22/current/>) and the HELCOM HUB classification (<http://vocab.nerc.ac.uk/collection/M23/current/>) have been uploaded on the NERC vocabulary servers.

We have initiated contact with a number of non-EU initiatives seeking collaboration:

- In 2017 we attended the Atlantic Seabed Mapping International Working Group meeting and presented the EMODnet Seabed Habitats portal and made proposals for interoperability with their data and their [North Atlantic Data Viewer](#). The portal developers (NOAA) were not present but the attending members of the working group agreed on the need for interoperability between the portals and promised to take the message to NOAA.
- We have also identified another source of potential collaboration – with the Horizon 2020-funded [SponGES project](#), who we spoke to at the Atlantic Seabed Mapping International Working Group meeting and were very keen on data exchange and interoperability between portals.
- In 2017 we attended the launch workshop of the Ecological Coastal Units (ECU) project (led by the United States Geological Survey and ESRI). We presented EUSeaMap and the EUNIS habitat classification and contributed to the definition of the objectives and methods for defining these ECUs based on our experiences and knowledge of marine classification approaches, potential issues and data availability. The work will be carried out by USGS and ESRI primarily, and we will act as advisors to the project.
- UNEP-WCMC “is seeking to convene an international network of intergovernmental and governmental focal points, including the Secretariat of the Convention on Biological Diversity (CBD), the Ramsar Secretariat, and the International Coral Reef Initiative Secretariat, to transform our understanding of where important habitats—such as seagrasses, warm- and cold-water corals, saltmarshes, and mangroves—can be found, and our ability to track and ground-truth their extent and condition systematically over time”. We agreed to share data from the data calls of this project and EMODnet Seabed Habitats and developed a joint statement to include in those data calls to explain the join-up to data providers. We have also agreed that the new EMODnet Seabed Habitats composite datasets for seagrass meadows and live hard coral will form the European component of the UNEP global datasets, which can be viewed with attractive graphical summaries on the [Ocean+ Habitats](#) website.

Task 7: Install a process to monitor performance and deal with user feedback

In line with all other EMODnet portals Europa Analytics has been installed on the EMODnet Seabed Habitats portal to enable enhanced monitoring of the web portal. To date user feedback (primarily via email) has been responded to, logged and reported on to the EMODnet Secretariat and DG MARE within the quarterly reporting of the project. At the end of Year 1 EMODnet Seabed Habitats launched a new helpdesk feature alongside other communications channels providing an enhanced user experience.

Task 8: Operate a help desk offering support to users

A helpdesk was launched on the EMODnet Seabed Habitats portal in Year 1. The EMODnet Seabed Habitats team are now available to answer external queries from 0900-1700 (Brussels time), Monday to Friday via the online helpdesk, contact form, phone number or email address.

4 Challenges encountered during the reporting period

Main challenge	Measures taken
Difficulties in obtaining third party data.	At the Project Steering Group meetings in May and November 2018 we discussed the difficulties experienced by partners in trying to extract data from third party organisations. Sometimes organisations are willing to provide data but the data preparation process is long and they do not have the time or resources available to prepare and submit the data. We discussed various approaches available to us and subsequently followed up with further discussions with the EMODnet Secretariat and EMODnet Biology. We concluded that issuing 'data grants' to fund data owners to process and submit their data could be a promising approach. Unfortunately, the resources will not be available to do this in the upcoming phase of EMODnet.
Mapping habitats in the Barents Sea.	The EUNIS classification is not well developed further north in Europe and is not commonly used in habitat mapping in Norwegian waters or further north as the habitats within EUNIS do not accurately reflect the habitats present on the seafloor. We have extended the map to cover this area but it should be noted that unless further work is done to develop the EUNIS classification to better reflect the habitats present in these areas there will be limitations in the quality of the map which we are able to produce. It is our understanding that the new version of EUNIS includes a section for Arctic waters.
None of the individuals from our consortium were involved in the EMODnet Data Ingestion project, which makes engaging with that project more difficult than for all the other lots.	We have recommended the use of the Ingestion portal in a guidance document for Seabed Habitats partners who are seeking third-party data. All Seabed Habitats partners have registered as 'data centres' with the EMODnet Ingestion portal, which will allow them to process any data submission related to seabed habitats in their country or a neighbouring country.
Several partners have begun to approach third parties about acquiring their data and many of them have received some resistance.	The response varies by country as some have a more open data sharing culture than others. Some promising feedback that has been received, however, is that with some perseverance the data owners sometimes change their minds.
Finding the best way to engage with the RSCs has been a challenge – while it is important to involve the secretariats, it is often the working groups/expert groups who can really define the requirements. In	We identified individuals within the consortium with specific responsibilities for liaison with each RSC secretariat. These were: <ul style="list-style-type: none"> ○ Baltic: Elina Virtanen (SYKE) ○ Black Sea: Valentina Todorova (IO-BAS) ○ Mediterranean: Leonardo Tunesi (ISPRA) ○ North-east Atlantic: Helen Lillis/ Amy Ridgeway (JNCC) We held several conversations with RSC representatives and have made moderate progress.

addition, it seems like with all the effort made to date, more work is needed to promote the offerings of EMODnet. EMODnet portals are not yet considered the default source of data for RSC groups.	
In developing the templates and guidance for publishing habitat point data we found that most habitat classification systems were not represented online as standard controlled vocabularies.	We got in contact with the British Oceanographic Data Centre have now generated controlled vocabularies for the most common classification systems so that data inputters can refer to a standard unique resource identifier (URI) for a habitat type or classification system. A related issue is that biotopes or communities are sometimes attributed to points based on ad hoc statistical analyses, and therefore they do not correspond to any particular classification system.
There is limited full-coverage environmental data available to use in the extension of EUSeaMap to the full Barents Sea.	We have had to produce a relatively simple model for this area that is more reliant on using depth proxies for defining the boundaries of biological zones, and excludes any distinction between high, moderate and low energy areas.
Achieving the requested resolution for EUSeaMap will be difficult in many areas due to the resolution of the available environmental datasets. For example, EMODnet Geology expect to achieve the 1:100,000 scale for less than 10 % of European seas for its seabed substrate data product (a key input to EUSeaMap).	We have produced the new broad-scale map using the finest resolution possible, depending on the resolution of the underlying data in any given area.
Preparation of habitat maps for publishing on the portal	Many partners had problems with the generation of INSPIRE-compliant metadata for the map collation process and this has had to be manually repeated by the work package lead for almost all of the maps collated. This process could be avoided in the future if the INSPIRE Editor online was upgraded and maintained so the resulting metadata it creates passed the online validation test.
Uncertainty about how to comply with the General Data Protection Regulations	Personal data is now, by default, encrypted across our webpages; access to the backend databases powering the website is restricted to senior software developers; and we no longer include any personal data in the quarterly reports. There was some discussions at the last Technical Working Group about implementing MarineID across all EMODnet Lots which would provide anonymous means of accessing EMODnet data & services, but this will require further work from the Lots and Secretariat to implement the service uniformly.

5 Allocation of project resources

Categories	Resource usage (%)
Making data and metadata interoperable and available	40%
Preparing data products	25%
Preparing web-pages, viewing or search facilities	20%
Managing user feedback	1% ¹
Project management	10%
Outreach and communication activities	4%
Others	

¹ Time spent by the project team dealing with user feedback figure low due to limited user feedback being received in comparison to the time taken to complete other tasks. All user feedback has been actioned swiftly (see Section 7).

6 Work package updates

Work Package 1 – Data preparation (WP lead: Ifremer)

The aim of WP1 was to prepare the spatially-continuous layers that are required for the broad-scale seabed habitat map produced by WP2. This includes the environmental layers (e.g. wave-induced energy, light at the seabed), the DTM and seabed substrate. The latter two were prepared in liaison with EMODnet Bathymetry and Geology lots.

Table 1 summarises the data layers that have been created and compiled. We have derived most of them from CMEMS products. The time-series gridded datasets have been downloaded from the CMEMS portal and post-processed in order to derive values at the seabed. The values have subsequently been integrated over time in the form of percentiles 90th or averages.

Obtain predictions of kinetic energy at the seabed

In the Black Sea, IO-BAS developed a long-term wave hindcast in the western part at 3 km resolution and two small areas at resolution around 400m. As part of this WP ISPRA post-processed 11 years of data to evaluate the 90th percentile of wave energy at the bottom of the 3km resolution area. These three areas do not cover the entire Black Sea and, moreover, the resolution of the most extensive one is not sufficiently fine to substantially improve the previous results obtained in Phase 2. As a result, ISPRA decided to provide a new evaluation of the sea bottom wave energy at high resolution using EMODnet Bathymetry and the available high resolution winds. The resolution of the total new domain of Black Sea is 1/64°, and two nested areas have also been processed, the resolution of which is 1/128° (i.e. around 1km) and the union of which covers all the Black Sea. The available data covers the period 2016-2018.

For Macaronesia and Iberia layers were produced from archives relative to two Copernicus CMEMS products: "atlantic-iberian biscay irish- ocean physics analysis and forecast" for temperature, salinity and currents, resolution 1/36 x1/36° and "atlantic-iberian biscay irish- ocean wave analysis and forecast" for waves, resolution 1/10 x1/10°.

Improve the mapping of the oxygen regime in the Black Sea

The anoxic environment in the deep areas of the Black Sea has an impact on the benthos; therefore it was important to represent the oxygen regime as a habitat descriptor in the full-detail classification of the broad-scale habitat map. In phase 2 we only had access to contour data showing lines of constant water density (used as a proxy for oxygen concentration). In this phase we were able to create a continuous dataset of density at the seabed using the CMEMS salinity reanalysis SU04-BS-CMCC-SAL-REAN-M and monthly potential temperature products at the seabed postprocessed to evaluate the salinity at the seabed and using the (linearised) equation of state to evaluate seabed density.

Identify and compile new environmental data layers for the Baltic Sea

Turbidity from suspended sediments makes it difficult to use the same approach to mapping light availability at the seabed in Baltic Sea as used in the rest of Europe. Instead, we relied on data from Secchi disk depths. In this phase we were able to make use of better data along the Swedish and Finnish coast using the photic zone spatial distribution produced by fine-scale national studies (Hammar et al, 2018², Lappalainen et al,

² Hammar, Linus, Jan Schmidtbauer Crona, Gustav Kågesten, Duncan Hume, Jonas Pålsson, Malin Aarsrud, Daniel Mattsson, Frida Åberg, Marie Hallberg, Thomas Johansson. 2018. Symphony, Integrerat

2019³) to define the infralittoral/circalittoral boundary. Unfortunately, the continuous data (owned by partner SYKE and the Swedish Geological Survey) are not freely available to share with the public; we were only provided with a categorical photic/non-photoc dataset.

Salinity is an important environmental factor for habitats in the Baltic Sea. In this phase we were able to make use of an improved dataset of salinity for part of the region in the Finnish Exclusive Economic Zone, owned by our partner SYKE.

Identify and compile environmental data layers for the Barents Sea

An important environmental factor for seabed habitat mapping is the light available at the seabed. Over the various phases of EMODnet, the Seabed Habitat lot has gradually extended the coverage of this data product using MERIS archive datasets on surface PAR (Photosynthetically Available Radiation) and KdPAR (attenuation coefficient of the PAR). In the current phase the spatial coverage was extended by creating new datasets for Iceland and the Barents Sea, through a contract with ACRI-ST (who previously carried out the work for other regions).

SYKE made a bid for a project with Russian colleagues around data in the Barents Sea, which unfortunately was unsuccessful. A decision was then taken to extend the thresholds prevailing in Norway into the Barents Sea using EMODnet base layers such as depth, light and substrate.

Liaise with EMODnet Geology, Bathymetry, Physics & Chemistry, Biology

Geology

The Seabed Habitat lot has worked closely with Geology. The Geology lot's seabed substrate products are key inputs to the broad-scale habitat map, hence it was crucial to liaise with the lot and be provided with a copy of these products earlier than the official release. JNCC, ISPRA, HCMR, Ifremer and Bioconsult met with Geology leads in Oct 2017 to discuss substrate issues. We discussed two topics:

- a) how to deal with bioclastic fraction of surface sediments;
- b) what is needed in terms of seabed geomorphology and what Geology can do.

HCMR created a log file to track individual local issues to facilitate Seabed Habitats partners feeding back issues to the relevant Geology partner.

Bathymetry

The Bathymetry lot's DTM product is also a key product for our purpose. A partner of the Bathymetry lot attended the EMODnet Seabed Habitats Brest progress meeting (November 2018) to make a presentation on the new quality index that the lot has developed for the 100m resolution DTM. The new DTM enabled us to improve all secondary layers based on bathymetry (e.g. thresholds of biozones).

Physics and Chemistry

Ifremer have been in touch with Mediterranean benthic ecologists about the justification for a Rhône plume area mask and with EMODnet Physics regarding river flow data. Discussions did not lead to significant enough benthic drivers to make such a mask, so the idea was ruled out.

planeringsstöd för statlig havsplanering utifrån en ekosystemansats. Havs- och vattenmyndighetens rapport 2018:1

³ Lappalainen, J., Virtanen, E.A., Kallio, K., Junttila, S., Viitasalo, M., 2019. Substrate limitation of a habitat-forming genus *Fucus* under different water clarity scenarios in the northern Baltic Sea. *Estuarine, Coastal and Shelf Science* 218, 31–38. <https://doi.org/10.1016/j.ecss.2018.11.010>

EMODnet Physics also helped us identify the best data source for the calculation of the ice edge in the Barents Sea.

JNCC have agreed with EMODnet Physics that they will also show the physical layers we have produced to give them more publicity.

Biology

Biology produced a wish list in a Google document which was commented on by Ifremer and partners were invited to also add their contributions. JNCC have made all layers available via WMS so that Biology can access them directly from R scripts for their modelling.

Producing a full-coverage seabed substrate layer suitable for broad-scale habitat map

The Geology lot makes available four seabed substrate products, one for each of the following scales: 1:1,000,000, 1:250,000, 1:100,000 and 1:50,000. In order to make a suitable input for the purpose of broad-scale seabed habitat mapping from these layers, we have combined them into a single layer that contains the best scale available at each location. We have also added *Posidonia* meadows polygons in the Mediterranean Sea into that layer, and some other substrate polygons that were rejected by EMODnet Geology but deemed important for better mapping of habitats, such as the seabed substrate layer produced in the MeshAtlantic Project for the Azores, the seabed substrate layer produced in urEMODnet for the Western Mediterranean, additional rock polygons in Norway and the UK.

Table 1: Environmental data layers created and compiled in phase 3.

Regional Domain	Variable	Data source	Horizontal coverage	Horizontal resolution	Temporal coverage
Black Sea	Current energy	CMEMS	Full coverage	1/36x1/27 °	2016-2018
	Density	CMEMS	Full coverage	1/36x1/27 °	2011-2017
Baltic Sea	Salinity	SYKE	Finnish EEZ	20 m	2004-2015
Mediterranean	Current energy	CMEMS	Full coverage	1/24 °	2016-2018
Atlantic	Current energy	CMEMS	Macaronesia	1/36 °	2013-2018
	Current energy	CMEMS	Iberian-Biscay-Ireland	1/36 °	2013-2018
	Temperature	CMEMS	Iberian-Biscay-Ireland	1/36 °	2013-2018
	Salinity	CMEMS	Iberian-Biscay- Ireland	1/36 °	2013-2018
	Wave energy	CMEMS	Macaronesia	1/12 °	2016-2018
	Wave energy	CMEMS	Biscay - Iberian Peninsula	1/24 °	2016-2018
	KdPAR	MERIS	Iceland	250 m	2005-2009

	Surface PAR	MERIS	Iceland	4 km	2005-2009
Arctic	Ice cover	CMEMS	Barents	1 km	2018
	KdPAR	MERIS	Barents	250 m	2005-2009
	Surface PAR	MERIS	Barents	4 km	2005-2009

Work Package 2 – The broad-scale seabed habitat map: modelling, thresholds and confidence (WP lead: Ifremer)

WP2 dealt with developing tools to produce the broad-scale seabed habitat map (EUSeaMap), working out new thresholds where relevant, and, eventually, producing a new broad-scale seabed habitat map for all Europe (including the new area Barents Sea) and confidence layers. This was a joint effort that also included members of the phase 2 consortium.

Publication of technical report

At the beginning of the project we published a 174-page report⁴ describing all the technical details of the production of the 2016 version of EUSeaMap. This contains an important historical record of the steps taken, that would allow the reader to understand the method and the outputs.

Defining the habitat types to include in the broad-scale habitat maps

The habitat map has been classified to three classification systems to allow widespread usability:

1. EUNIS habitat classification system v2007-11 (levels 3 and 4) (Figure 1): this is the standard classification system for Europe, although it does not allow much definition in the deep-sea and is not deemed very applicable in the Baltic and Black Sea.
2. MSFD benthic broad habitat types: this is a coarse scale classification system that is of relevance to all EU Member States due to its links to the MSFD.
3. Full-detail classification: this incorporates EUNIS classes where EUNIS is relevant, as well as additional classes to add a finer level of detail that are not addressed at the higher levels of EUNIS, where relevant. E.g. dividing by salinity regime in the Baltic, oxygen regime in the Black Sea, ice-cover in the Barents Sea and water masses in the deep-sea.

Correlating MSFD benthic broad habitat types and full-detail classification

At the beginning of the project we published a table that correlates MSFD Benthic Broad Habitat types⁵ and the full-detail habitats types used in EMODnet broad-scale seabed habitat maps⁶.

Black Sea habitats

A meeting took place in April 2018 at IO-BAS (Varna, Bulgaria) to assess the broad-scale habitat map which was produced in 2016 as part of EMODnet Phase 2 and brainstorm on solutions to the identified issues. A key output of the meeting was a revised version of the broad-scale habitat classification for the Black Sea. The

⁴ Populus Jacques, Vasquez Mickael, Albrecht James, Manca Eleonora, Agnesi Sabrina, Al Hamdani Ziad, Andersen Jesper, Annunziatellis Aldo, Bekkby Trine, Bruschi Antonello, Doncheva Valentina, Drakopoulou Vivi, Duncan Graeme, Inghilesi Roberto, Kyriakidou Chara, Lalli Francesco, Lillis Helen, Mo Giulia, Muresan Mihaela, Salomidi Maria, Sakellariou Dimitris, Simboursa Mika, Teaca Adrian, Tezcan Devrim, Todorova Valentina, Tunesi Leonardo (2017). **EUSeaMap. A European broad-scale seabed habitat map.** <https://doi.org/10.13155/49975>

⁵ Marine Strategy Framework Directive Benthic Broad Habitat Types (V. 2017) as defined in: COMMISSION DECISION (EU) 2017/848 of 17 May 2017

⁶ Manca E., Lillis H., Annunziatellis A., Agnesi S., Mo G., Tunesi L., Parry M., Doncheva V., Al-Hamdani Z., 2017. The MSFD Benthic Broad Habitat Types Tables. Annex to Populus J. et al., 2017

updated list of these habitats is provided in Annex I along with their definition in terms of seabed substrate and abiotic variables, and the acknowledged benthic assemblages hosted by these habitats. A revised version of the above-mentioned correlation table between benthic broad MSFD habitats and the broad habitat types used in EMODnet broad-scale seabed habitat maps is provided in Annex II.

Biogenic substrate

In preparation for the publication of the new version of the EUNIS classification system, we made a plan for how to include polygons of “biogenic substrate”, which is to be included as a substrate type in level 2 of the new system. This involved compiling a list of habitat types that would qualify as biogenic substrate (e.g. “*Lophelia pertusa* reefs”, “Pacific oyster beds”, etc.). The plan was to extract these polygons from the habitat maps from surveys compiled in WP5. We agreed that “biogenic substrate” strictly refers to beds or reefs of a species that meet similar criteria to Mediterranean *Posidonia oceanica* meadows in that they:

- Cover and replace the underlying substrate as a structuring factor, so that the underlying substrate cannot be detected;
- Occur on different substrate types, so that the underlying substrate cannot be presumed;
- Are detectable using acoustic survey techniques, so that they are mapped in the same way as other substrate types.

The polygons were not included in the 2019 version of EUSeaMap because the new version of EUNIS has not yet been published.

Carrying out analyses to identify biologically-relevant thresholds

Updating thresholds

In EMODnet phase 2, for separating between oxic, suboxic and anoxic areas in the Black Sea, 2 density isolines, which were the intersection of the isopycnic surfaces 15.6 kg.m^{-3} and 16.4 kg.m^{-3} with the seabed, were used. With the production of a new, full-coverage gridded layer on density in phase 3 (see WP1 section), new density thresholds had to be worked out. The analysis resulted in values of 15.9 kg.m^{-3} and 16.4 kg.m^{-3} for, respectively, the oxic/suboxic and the suboxic/anoxic boundaries.

In the Bay of Biscay and the Iberian Peninsula, the new wave energy layer produced from a CMEMS product has brought substantial improvement in terms of spatial resolution in Northern Spain and the strait of Gibraltar. The threshold analysis led to values of 40 N.m^{-2} for the low/moderate energy boundary, and 80 N.m^{-2} for the moderate/high energy boundary.

Updating the boundaries between the shelf/bathyal and bathyal/abyssal in the Mediterranean and Black Sea

In the Mediterranean Sea and the Black Sea, in the broad-scale habitat map the boundary between the shelf and the bathyal on one hand, and the bathyal and abyssal on the other hand, are defined based on slope changes. These boundaries have been updated in order to take into account the improved spatial accuracy provided by the new 100m resolution DTM provided by EMODnet Bathymetry (Figure 2).



⁷ View EUSeaMap on the interactive map: <https://www.emodnet-seabedhabitats.eu/access-data/launch-map-viewer/?zoom=4¢er=-3.508,52.305&layerIds=1&baseLayerId=-3&activeFilters=>

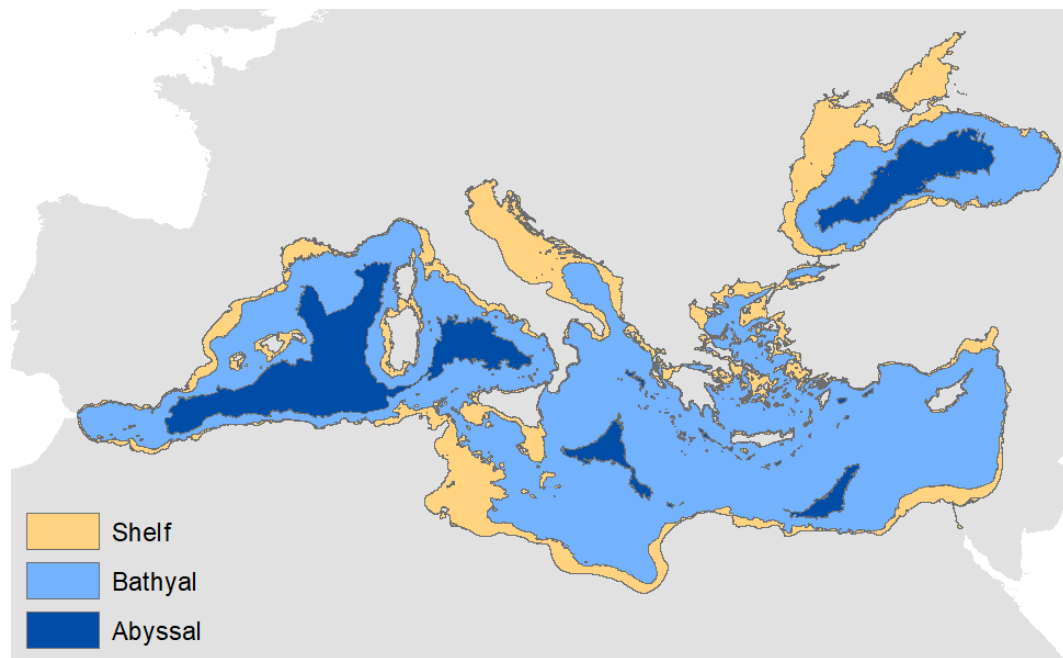


Figure 2: The shelf, bathyal and abyssal areas in the Mediterranean Sea and the Black Sea

Producing for all Europe an updated broad-scale seabed habitat map together with spatially-explicit confidence maps

A new GIS workflow, based on open-source software

In previous phases of EMODnet, we used a commercial software (ArcGIS) for producing the broad-scale seabed habitat map. One of the objectives of phase 3 was to develop a tool based on open-source technologies and that would be repeatable and transposable across basins.

After testing several options, we choose to use R and the 'Raster' package for raster calculations, and R together with GRASS software for overlaying polygon layers. The GIS workflow (Figure 3) has been implemented in the form of a series of R scripts. Each habitat descriptor layer (i.e. biological zone, oxygen regime, energy regime, etc) is 1) produced as a raster, and 2) converted to a polygon layer. Then 3) all habitat descriptor layers, including those which are provided ready-to-use (e.g. the seabed substrate layer provided by EMODnet Geology), are overlaid to create the habitat layer. 4) After the overlay, a lookup table that correlates numeric habitat codes and various classification classes (e.g. EUNIS, MSFD broad habitat types) is joined to the habitat layer.

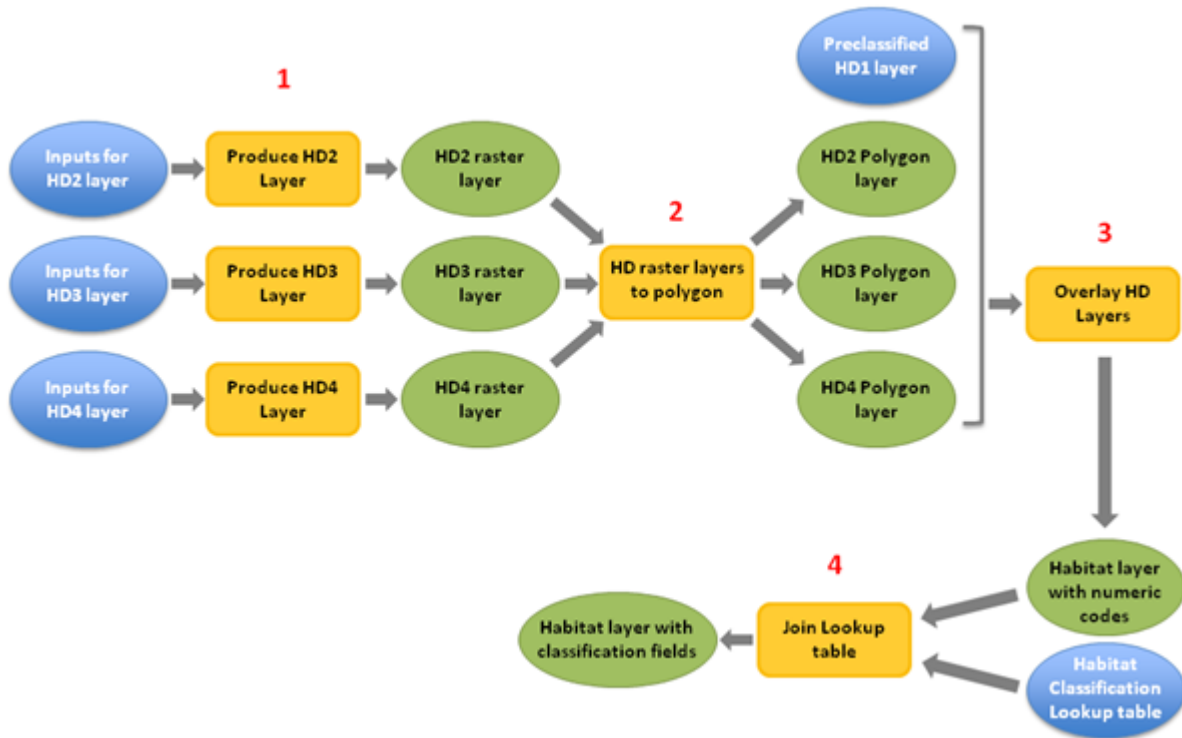


Figure 3: The EUSeaMap overall GIS workflow. All habitat descriptors (HD) layers are 1) produced as rasters, 2) converted to polygon, 3) overlaid to create the habitat layer. After the overlay, a lookup table that correlates numeric habitat codes and various classification classes is joined to the habitat layer (4).

Automating the production of the confidence maps

In phase 2 a method was developed for the spatially-explicit confidence assessment of the broad-scale habitat map and the underlying habitat descriptor maps. In phase 3, this assessment has been implemented in the R scripts, hence facilitating the production of these confidence maps. Figure 4 shows an example of the confidence map for the final EUNIS-classified map in the Baltic Sea.

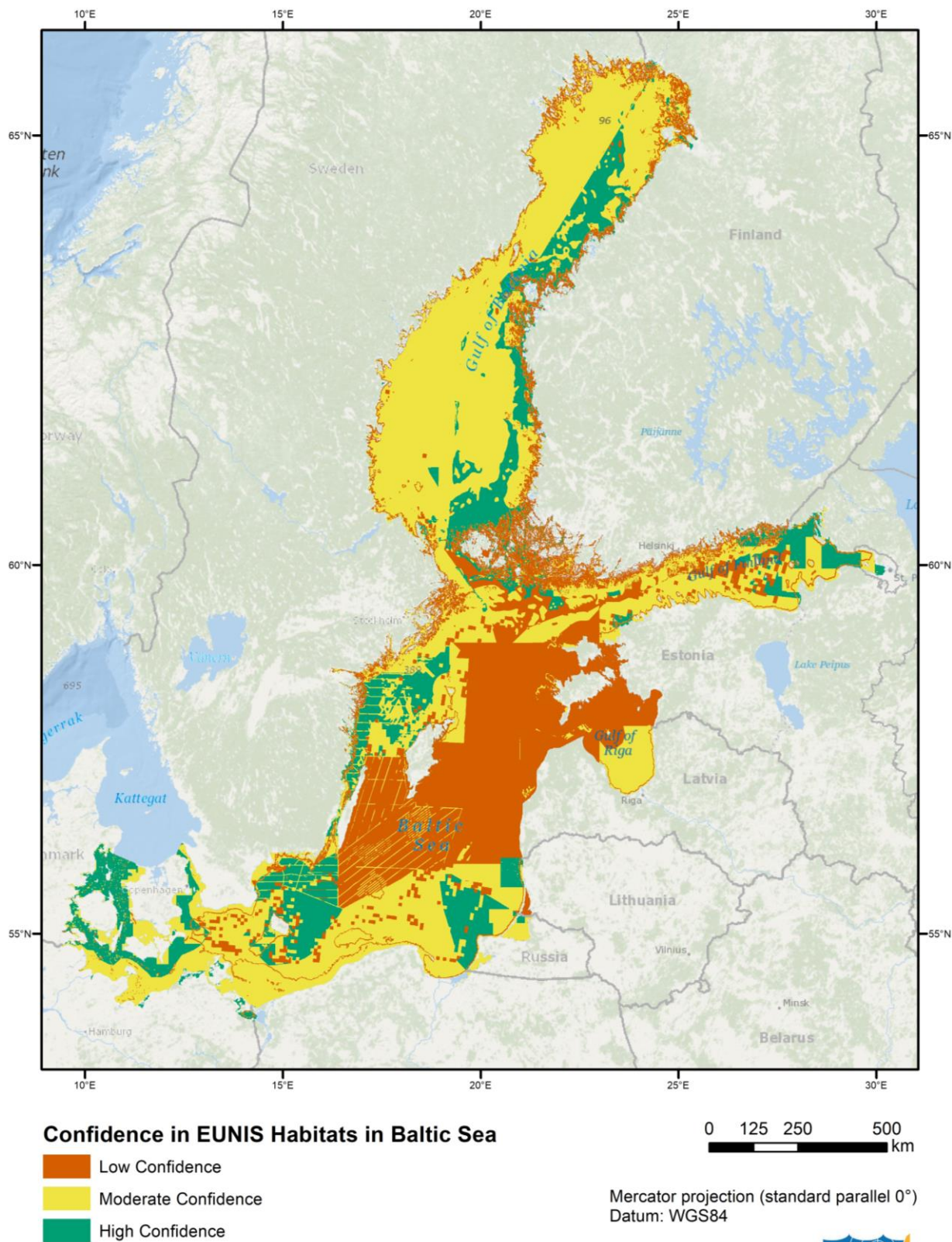


Figure 4: Map of confidence in the classification of EUNIS habitats in the Baltic Sea.

Allowing varying spatial resolution

One of the main challenges of this new phase was to adapt the method in order to allow multi-resolution, thus keep the full spatial accuracy of the seabed substrate layer provided by EMODnet Geology. For this objective to be achieved, we had to reconsider the raster-based approach that had been used since the preliminary phase of EMODnet. This approach entailed producing the habitat map at a fixed resolution, hence with loss of spatial detail. In the new workflow, the final overlay of the habitat descriptor layers is performed in polygon mode. Figure 5 highlights the benefit of the method adjustment, in an area where the underlying seabed substrate map is at a fine-grained scale.

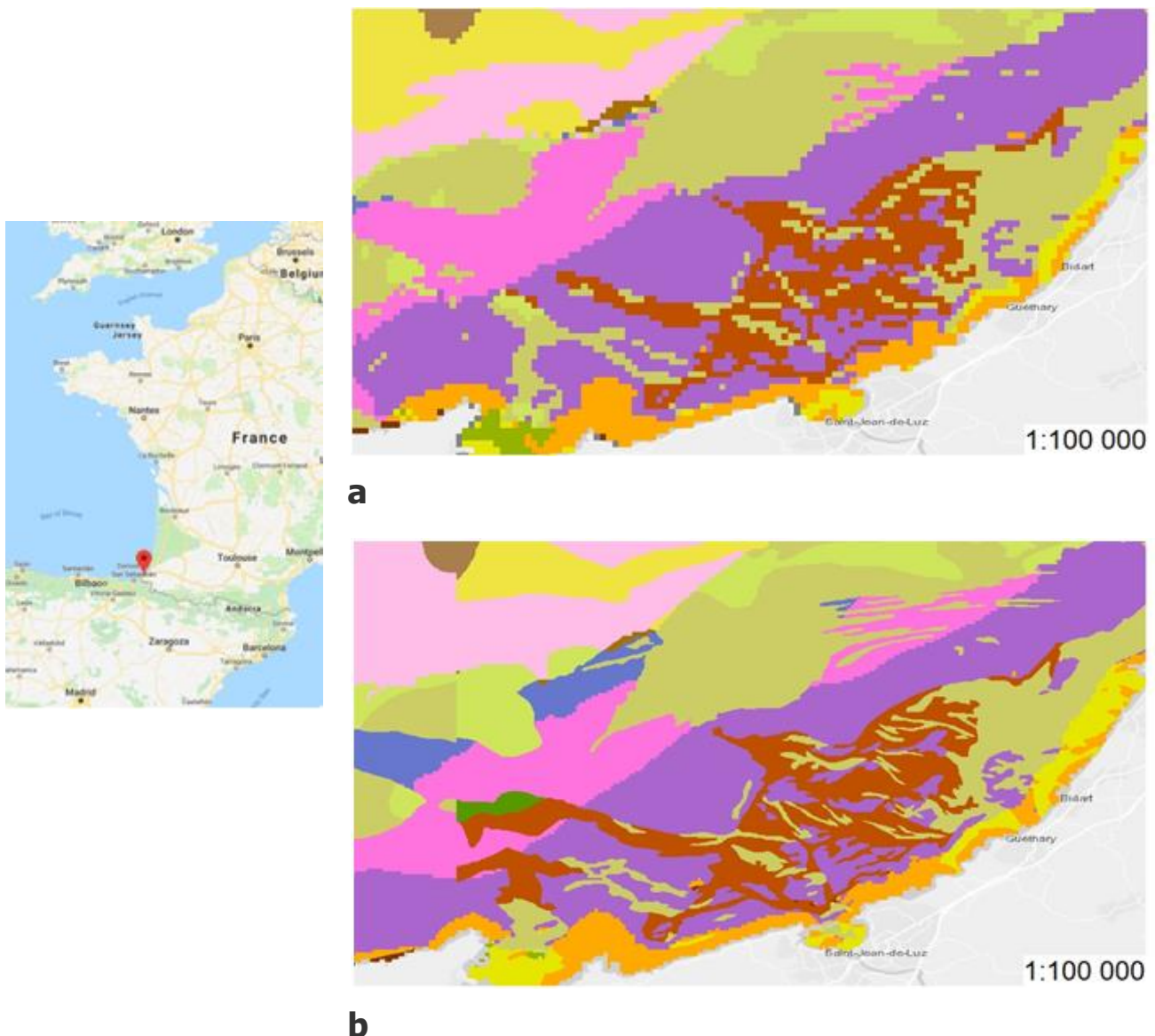


Figure 5: The broad-scale seabed habitat map, with a focus at the 1:100,000 scale on an area off St-Jean-de-Luz (France) to illustrate the improvement of the map in terms of spatial resolution between the version 2016 (a) and 2019 (b).

Work Package 3 - Individual habitat modelling (WP lead: SYKE)

Review of modelling activities

As part of WP3 we produced an overview of habitat modelling activities around the European sea areas. To achieve an overview of what modelling studies have already been carried out in Europe, we did an extensive literature search, concentrating only on scientific, peer-reviewed studies. Our goal was to identify all relevant exercises that could be categorised as “seabed habitat modelling studies”.

Using Web of Science, we identified 3,377 articles that could be categorized as being “marine habitat modelling” studies. These articles were reviewed based on the title and geographical area, resulting in 289 articles that dealt with marine habitat mapping and modelling in the European Seas. Based on abstracts and content, we identified 54 papers dealing with only habitat modelling in the European seas, and all mapping efforts (surveys, samplings) were excluded from the analyses. In addition, we did not include grey literature (reports), books, or book chapters. We conducted the qualitative data analysis using the Nvivo program. As a result, we identified the most important sources for retrieving predictive habitat model outputs, most relevant environmental data used in models, most common marine habitats modelled, extensively used modelling algorithms, typical extent and resolution of models, taxonomic levels addressed, modelled depth ranges, and summaries of studies for each regional sea. We also discussed the caveats of modelling, knowledge gaps, and potential improvements in modelling activities.

This review of habitat modelling activities is available to download via our ‘Documents and Outreach’ web page⁸.

Collation of habitat models

Another goal of WP3 was to collate predictive habitat model outputs⁹ so that they may be discovered and accessed via the EMODnet Seabed Habitats portal. This activity was not specifically requested in the tender specification; however, the consortium felt that it was an important gap that EMODnet Seabed Habitats are well-placed to address.

To achieve this, we first looked at the model outputs identified from scientific literature in the review of modelling activities as well as other model outputs identified by partners in their own institutions, in their own country, or that they knew of otherwise from any source.

All the information was collected into an Excel spreadsheet, and in total 147 individual model outputs were identified and listed. Based on the Excel list, we sent 104 separate requests regarding relevant predictive habitat model outputs that were going to be collated to the EMODnet Seabed Habitat portal. Most requests were sent to institutions within the 12 partner countries but requests were also sent to third party countries (Estonia, Lithuania and Russia).

After successful and failed requests, 54 model outputs were received and uploaded to the portal¹⁰. We received model outputs from Ireland, the United Kingdom, Finland, France, Germany, Greenland and Norway.

⁸ <http://umbraco-staging/resources/documents-and-outreach/>

⁹ ‘Model outputs’ here refers to spatial layers showing either habitat suitability/likelihood on a scale from 0-1, or a categorised output showing predicted presence or absence of a habitat.

¹⁰ View all collated models on the interactive map: <https://www.emodnet-seabedhabitats.eu/access-data/launch-map-viewer/?zoom=4¢er=-3.508,52.305&layerIds=950,951,952,953,954,955,956,957,958,959,960,961,962,963,964,965,966,967,968,969,970,971,972,973,974,975,976,977,978,979,980,981,982,983,984,985,986,987,988,989,990,991,992,993,994,995,996,997,998,999,1000,1001,1002,1003,1010,1011,1012,1013,1014,1015,1016,1017,1018,1019,1020,1>

Moreover, global, Atlantic-wide and Baltic Sea-wide habitat model outputs were collated as well. Some of the collated model outputs were not identified in the listing as some individual researchers submitted their own models and studies spontaneously. Also, some of the identified model outputs were already part of the EMODnet data portal and were not collated again.

Several research institutes and individual researchers were approached but lack of time was the most general reply for not responding to requests.

Work Package 4 – Ground truthing data (WP lead: ISPRA)

Design a data schema

The first task in this WP was to identify a suitable database schema. Feasible structures were shared among the project partners and we evaluated the possibility of constructing a schema that would be interoperable with the main existing biological database (i.e. those used by EMODnet Biology and the structure used by OBIS (Darwin Core), with particular reference to the new extension OBIS-ENV).

A specific meeting with EMODnet Biology, attended by JNCC, ISPRA and VLIZ, was held in Ostend in July 2017. During this meeting the WP4 database schema was shared with VLIZ colleagues in order to evaluate the compatibility between our structure and Darwin Core. During the following months VLIZ and the WP4 leaders continued discussions in order to improve the interoperability between the respective systems.

Based on the result of this meeting and feedback provided by WP4 partners, the final structure of the WP4 database was released immediately after the first EMODnet Seabed Habitats progress meeting in Athens (October 2017).

This version of the schema is comprised of three different sheets (metadata, sampling event and EMOF compliant information) and was released with some vocabularies already defined and linked to the allowed database entries (i.e. the authors can feed the database with the sampling point and related habitat information and the relative vocabulary entries are auto-completed). Furthermore, a guidance document for the compilation of the three sheets was created. Finally, if habitat ground truthing data is already present in EMODnet Biology only the EMOF sheet data is completed and for this reason a separate file with only the explanation of the EMOF compliant sheet and the relative vocabularies was also prepared.

Then, in order to support the compilation of the database, two teleconferences were held in November 2017 and January 2018.

In order to confirm the interoperability between the WP4 schema and the OBIS structure and to discuss in detail some issue concerning the vocabularies used in the database, a new teleconference was carried out in February 2018 with VLIZ colleagues. During this conference we agreed to share some test datasets that were sent to VLIZ.

Collate and provide access to information on the spatial distribution of habitats or communities

This year's activity was focused on data collation (both internal and third parties' data), on the QA/QC procedures and on the design the PostgreSQL web database.

Using the database schema developed during the first year of the project, all the partners collated and provided to ISPRA the internal datasets (i.e. referred to the partner's country) and have begun the requests for external data to the neighbouring countries' data owners.

This process has allowed us to collate a large number of point data covering all the marine sub-regions across Europe (Figure 6 and Table 2)¹¹.

In the UK there is already an established process for third party data collation via the [Marine Recorder application](#); all of the unrestricted data from Marine Recorder has been submitted to EMODnet. Third party data collation within other European countries was difficult and, to date, just a dataset from Belgium was successfully uploaded to the EMODnet Seabed Habitats portal. However, it is reasonable that some of the contacts made during this period will allow us to collate further external datasets in the future.

¹¹ View all collated ground-truthing points on the interactive map: <https://www.emodnet-seabedhabitats.eu/access-data/launch-map-viewer/?zoom=4¢er=-3.508,52.305&layerIds=700&baseLayerId=-3&activeFilters=>

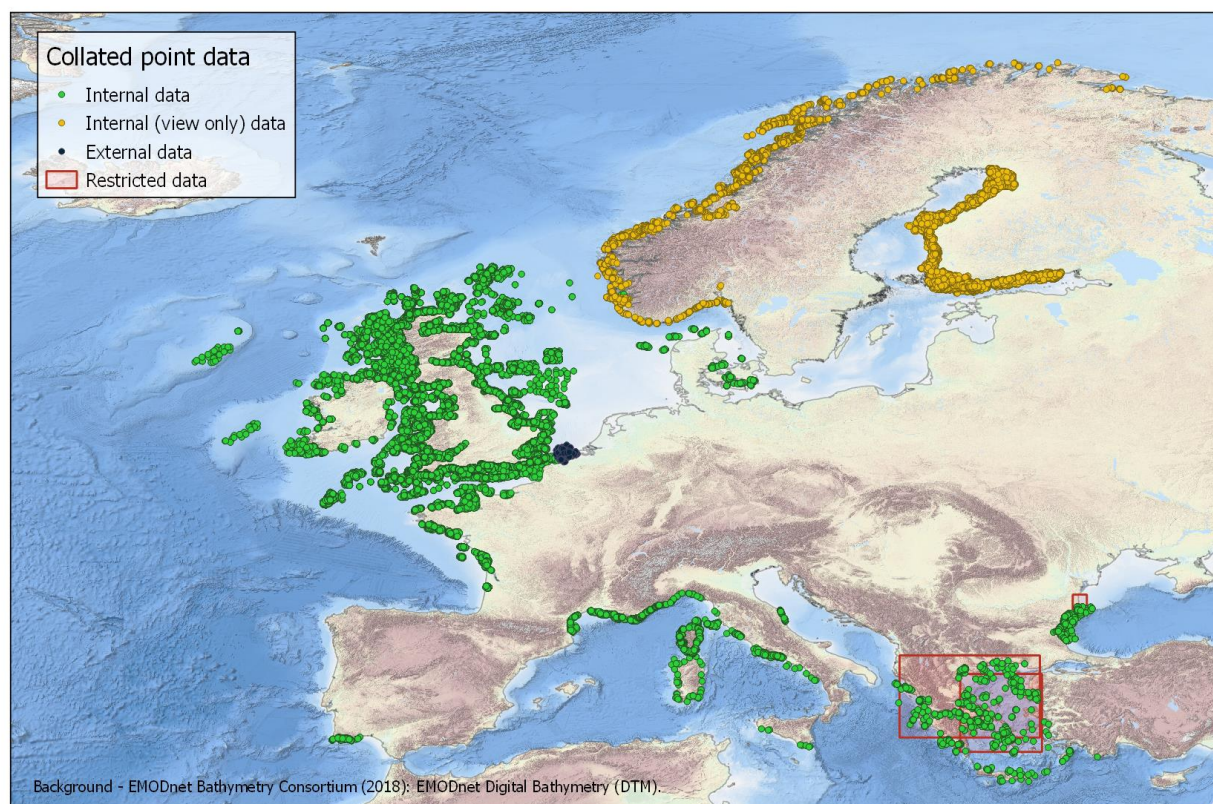


Figure 6: Ground-truthing survey points containing habitat information, collated by EMODnet Seabed Habitats in phase 3.

Most of the work done during the second year of the project was centred on the design and construction of the database structure to make the collated data available via the portal (using PostgreSQL database) and on the definition of automated QA/QC control procedures of the collated data.

Table 2: Summary of ground truthing survey points collated by EMODnet Seabed Habitats in phase 3.

	Collected datasets	Collected points	Free datasets	Free points
Oct 2018	2,100	292,765	2,094	170,705
Apr 2019	2,131	312,688	2,125	204,280

The QA/QC control phase is a two-step quality data check. The first part of the control procedure is carried out using a VBA script and works directly on the Excel format of the provided datasets. This procedure performs the following controls:

- presence of all the metadata information;

- ii. presence of all the mandatory fields in both the dataset tables;
- iii. presence of duplicate IDs;
- iv. coherence between IDs used in the two tables;
- v. correct use of the parentEventID field;
- vi. correct format of dates;
- vii. presence of errors in the depth fields.

Furthermore, at the end of the process, the script updates a report file in which a synthesis of the checked datasets status is reported. The second step of the collated data QA/QC is carried out during the import process into the PostgreSQL database and refers to the coherence between the requirements of the structure of the web database with the format of the Excel cells. In case of success of the both the above described procedures, collated data immediately feed the web database.

The database designed and developed within the WP4 activity is now fully operational and available via the EMODnet Seabed Habitats OGC web services (<https://www.emodnet-seabedhabitats.eu/access-data/web-services/>).

Linking up with OBIS

Another Year 2 activity was a pilot project to submit point data on habitats to the Ocean Biogeographic Information System (OBIS). Ultimately, we think point observations of habitats should be submitted to OBIS. However, this is not currently done, except occasionally as an optional additional piece of information associated with species occurrences (and even then it is not done in a standardised way). An opportunity presented itself with the aforementioned Marine Recorder database in the UK, which holds both species and habitats information, and which is uploaded to OBIS via a UK partner in the Biology lot, the Marine Biological Association (MBA). JNCC and MBA worked together to map the fields from the WP4 database to OBIS and translate the data accordingly. The next stage is to upload the data to OBIS and, if successful, to discuss with OBIS where this should be adopted as the standard approach for habitat data in the database.

Work Package 5 – Library of habitat maps (WP lead: Marine Institute)

Habitat map collation

In year 1 257 maps were collated by the 12 partners for this work package. In year 2, 167 more maps were collated¹², mostly according to the EUNIS classification system and Habitats Directive Annex I. As well as from partner countries, 11 maps from 3 countries outside of the project (Estonia, Malta and Spain) were collated (Figure 7). The maps have undergone the [EMODnet Seabed Habitats data submission process](#) and have all been checked for format and metadata compliance before being forwarded to JNCC for upload onto the EMODnet Seabed Habitats portal.

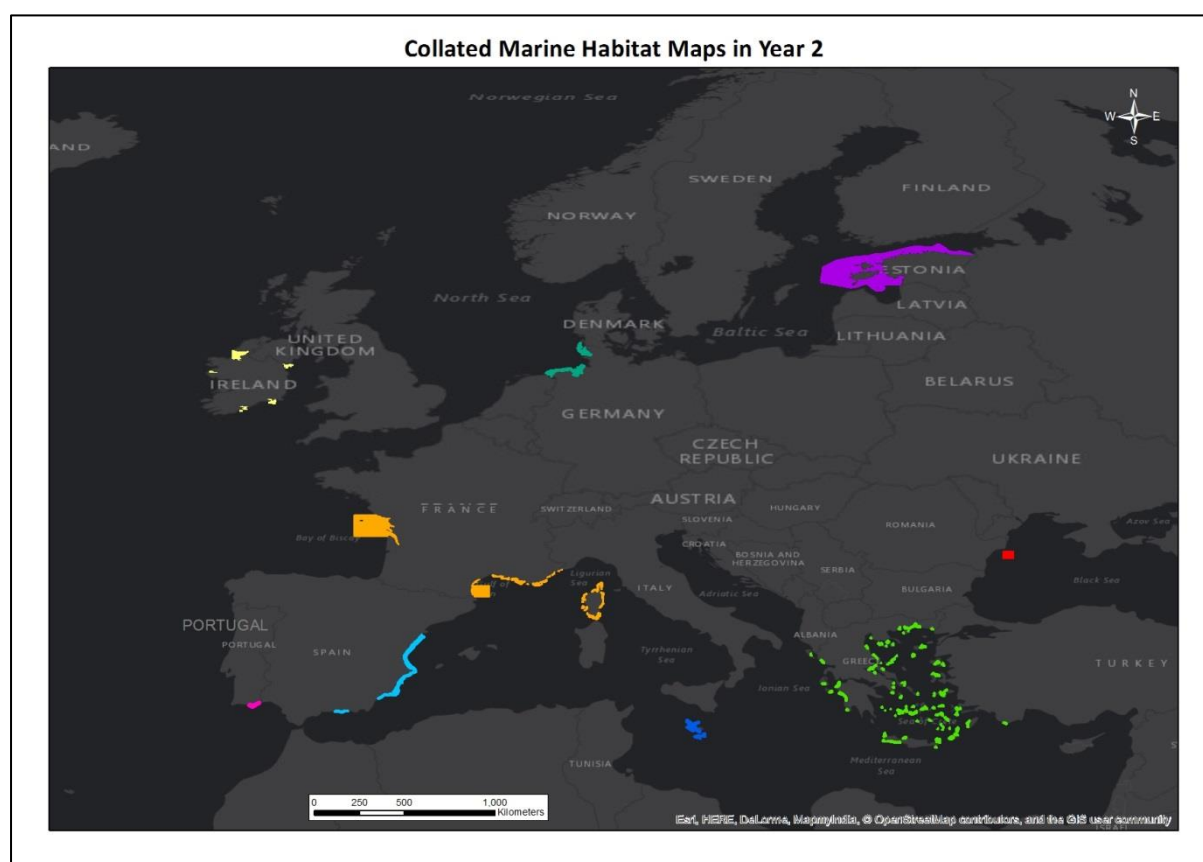


Figure 7: Maps collated by partners in their own country and in countries outside of the project in year 2.

There are a few maps listed in the proposal that were not collated as part of this WP due to these maps being more suitable to other data collation work packages (e.g. WP3, WP4 or OSPAR), or because the maps were incomplete or only available as a WMS. In most instances, partners collated alternative maps to those listed in

¹² View all collated habitat maps from surveys on the interactive map: <https://www.emodnet-seabedhabitats.eu/access-data/launch-map-viewer/?zoom=4¢er=-3.508,52.305&layerIds=500,501,502,510,520,521,522&baseLayerId=-3&activeFilters=>

the proposal to ensure the number they proposed were submitted. The figures for maps proposed and those submitted along with reasons for not submitting maps proposed is summarised in Table 3.

Table 3: Summary of maps submitted in year 1 with reasons for the maps that were not submitted.

Partner Country & Organisation	Number of maps proposed	Number of maps submitted	Number of maps not submitted	Reasons for maps listed in proposal not being submitted
Bulgaria (IOBAS)	6	6	0	N/A
Denmark (GEUS)	5 sets of maps	77	0	N/A
Finland (SYKE)	2 sets of maps	9	5	some of the product outputs from models were not suitable for inclusion in WP5
France (IFREMER)	12	12	4	4 alternative maps were submitted instead of the 4 maps listed in the proposal
Germany (BioConsult)	3	6	0	N/A
Greece (HCMR)	2	2	0	Additional data were listed in the proposal but these were more suited to WP3 & WP4
Ireland (MI)	3 sets and 9 maps	87	5	Some of the maps have been submitted elsewhere on the portal (e.g. Annex I grids and OSPAR)
Italy (ISPRA)	9	8	1	This map has been replaced by the data in map IT003006
Norway (NIVA)	1 set of maps	5	10	These maps were more suited to OSPAR and some were only available as WMS layers
Portugal (CCMAR)	8	1	0	All maps proposed were consolidated into one map (this was agreed at the Progress Meeting in Athens)
Romania (GeoEcoMar)	3	2	1	3rd map proposed is no longer in existence.
UK (JNCC)	10 sets and 4 maps	42	32	There are several reasons why some maps have not been submitted in Year 1: 1. JNCC staff resource has been focussed on portal updates and ingestion of large number of partner maps as lead of WP6 (so some UK maps will be uploaded in Year 2 instead); 2. Some maps are awaiting updates and will be uploaded once updated (e.g. Annex I composite maps); 3. Difficulty in extracting individual surveys from composite products (e.g. the CNCB Annex I maps), though these maps will be extracted to upload.

Composite data products: essential ocean variables

Three thematic layers showing the coverage of seagrass, hard coral and macroalgal forest in European waters were created to fulfil commitments to the generation of composite data products stated in the project proposal. These three habitats are three of four habitats on the Global Ocean Observing System (GOOS) list of 'essential ocean variables' (EOVs) in the 'Biology and Ecosystems' category.

They were selected following discussions with the Biology Lot, who were concurrently developing products related to the species-related EOVs, and with UNEP-WCMC, who maintain global datasets on these EOVs. The process is documented in a report available on the EMODnet Seabed Habitats website, entitled [Generating Essential Ocean Variables](#).

Lists of suitable habitats were created by the partners for each EOVI: Seagrass Cover, Live Hard Coral and Macroalgal Canopy Cover. The required habitat data were extracted from all of the maps on the portal and merged into single, standardised, INSPIRE-compliant spatial data layers. These data layers present the first attempt to map the areal extent of three EOVs in Europe. The data products (Figure 8) are available to view on both the EMODnet Seabed Habitats portal and EMODnet Biology's Atlas of Marine Life.

At the time of publication, the specification sheets that define these habitats on the GOOS website were still under development; therefore we used expert judgement to decide how to define them. Furthermore we identified some possible future improvements. Therefore, the three EOVI layers produced should be seen as a "work in progress". In particular, the definition of Live Hard Coral was difficult to interpret so it was decided just to include hard, reef-forming, cold water corals in deeper waters.

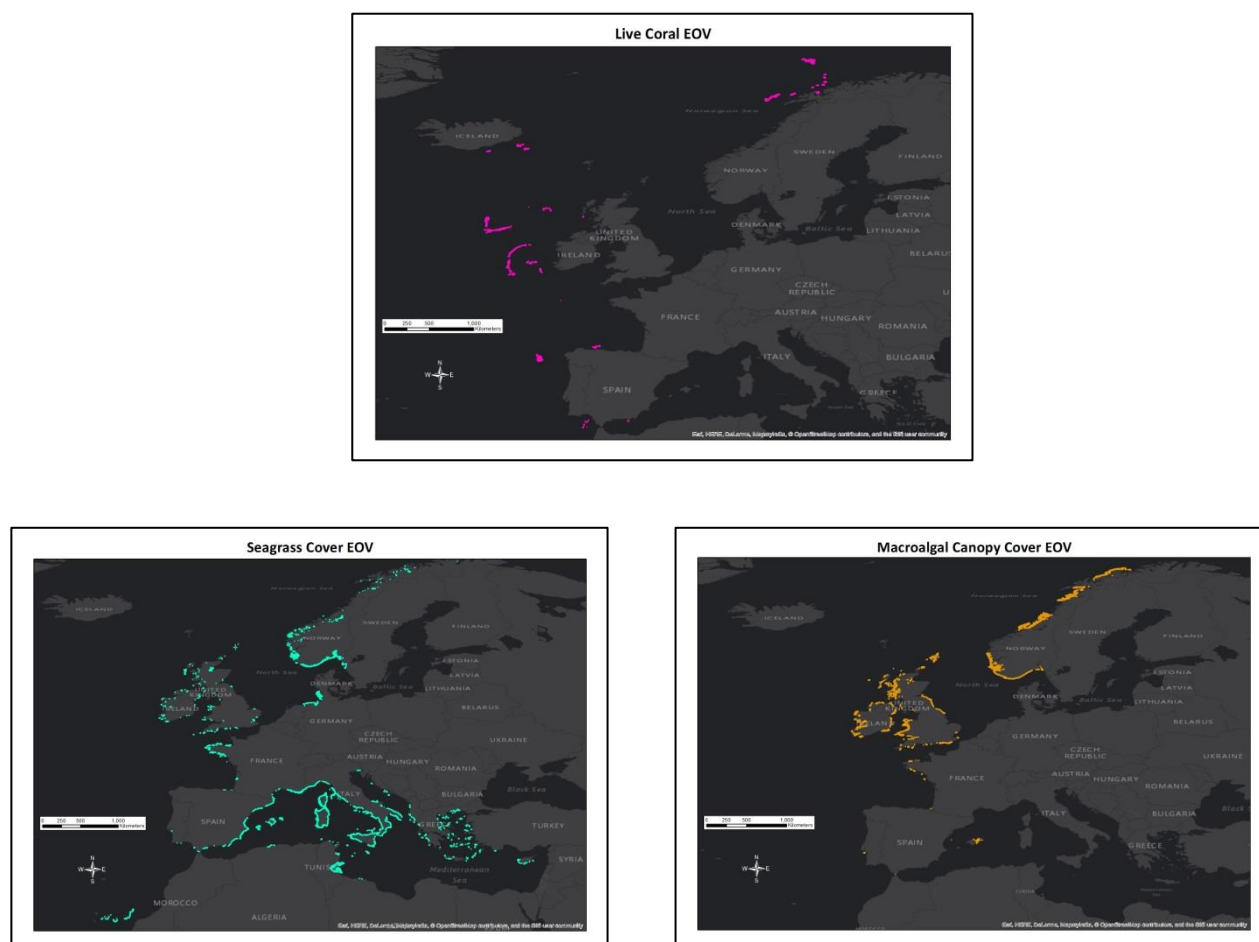


Figure 8: Clockwise from bottom left: EOVs for Seagrass, Macroalgae and Live Hard Coral.

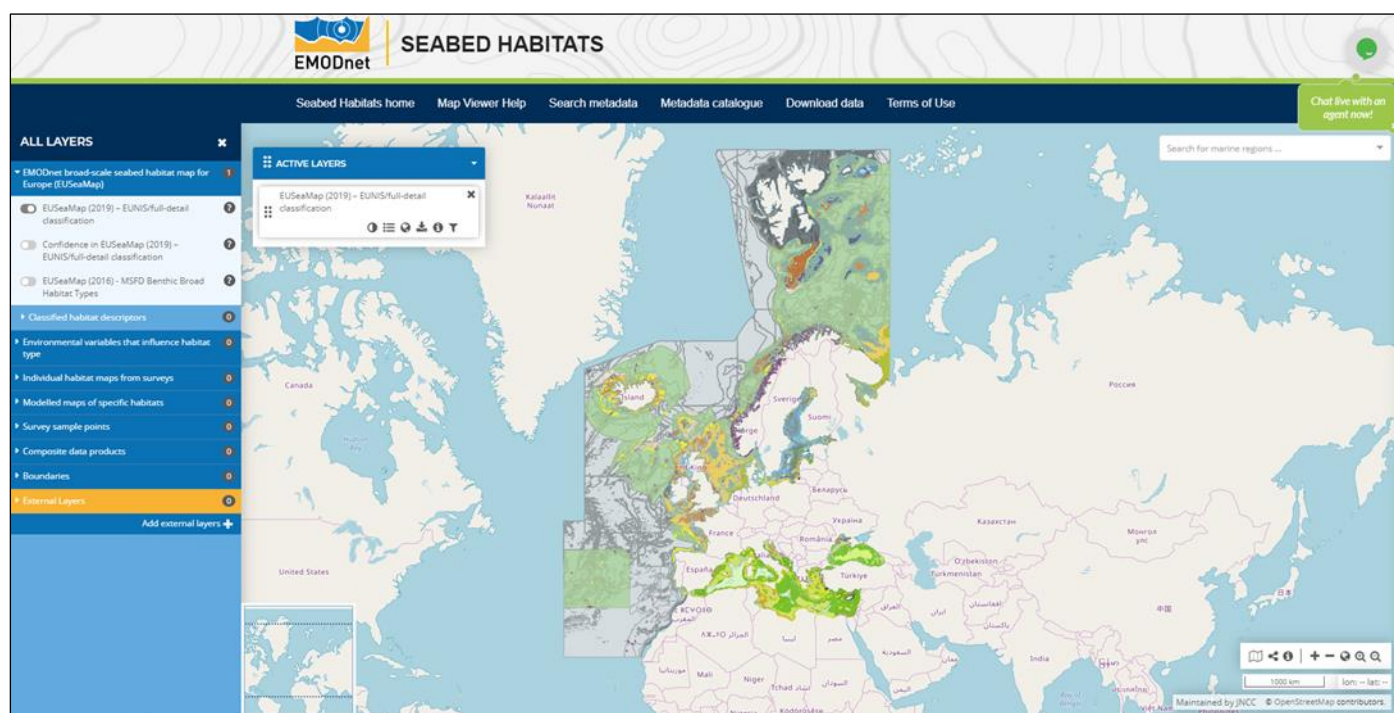
Work Package 6 – Portal and EUNIS application (WP lead: JNCC)

In the first year of the project JNCC oversaw a contract to move the EMODnet Seabed Habitats website over onto the open-source Umbraco Content Management System. The new website was launched in May 2018 and the website design was refreshed to conform with the updated EMODnet Style Guide. Additional functionality now included on the website includes:

- A dedicated EMODnet Seabed Habitats helpdesk including online chat powered by tawk.to and an online contact form in addition to email address and phone number;
- An up-to-date RSS news feed.

In the second year of the project JNCC have continued to improve and update the EMODnet Seabed Habitats portal including adding new pages on many different uses of the EMODnet Seabed Habitats products. The news section has been kept up-to-date and the online helpdesk has now been operational for a year providing instant access support to users via a live web chat.

JNCC have overseen a contract to overhaul the mapping platform which was previously built on technology which was over 10 years old. Prior to initiating the contract JNCC undertook an online user survey to gather information from users on mapper functionality. The new mapper is built entirely on open-source software including: GeoServer, PostGIS, GeoServer, Angular 7 and .NET Core 2.2. The new mapping platform should provide an enhanced user experience, introduces a range of new features, provides more integration with our GeoServer web services, and improved ability to exchange information with external OGC data services.



Extensive work has also been undertaken to facilitate the dissemination of seabed habitat data to end users. A Python workflow has been developed to improve the spatial data infrastructure and automate data management within Seabed Habitats, utilising GeoServer's API and extensive RESTful services. Future development aims to harvest and publish metadata to online portals utilising machine-to-machine communication, improving the exposure of EMODnet Seabed Habitat and access to stakeholders.

Although the Seabed Habitats project was not represented in the EMODnet Ingestion project consortium, we were proactive in building links with Ingestion. A representative was invited to one of our partner meetings to give an introduction and demonstration of the site. We recommended its use in a guidance document for Seabed Habitats partners who are seeking third-party data. All Seabed Habitats partners have registered as 'data centres' with the EMODnet Ingestion portal, which allow them to process any data submission related to seabed habitats in their country or a neighbouring country.

We have had initial discussions with the European Environment Agency (EEA) about the inclusion of distribution maps dynamically generated by EMODnet Seabed Habitats portal on the marine EUNIS habitat web pages, hosted by EEA. We plan to work with EEA to feed these maps via machine-to-machine connections directly from the EMODnet Seabed Habitats portals. They were receptive to this proposal but were not in a position to make changes to the website at the time.

All the spatial data and data products collating and produced in the other work packages have been uploaded to the web mapper, complete with metadata. At the time of writing, a few of the data and data products still need to be made available for download via the [download page](#). This will be completed as soon as possible.

Work Package 7 – Co-ordination and communication (WP lead: JNCC)

Co-ordination

Throughout the course of the project the work of the Partnership has been effectively co-ordinated and all quarterly reports and the final report delivered to EASME and the EMODnet Secretariat.

A memorandum of agreement between the partners was drawn up and signed by all project partners shortly after the contract was signed in May 2017.

JNCC have represented the EMODnet Seabed Habitats project at EMODnet Steering Committee and Technical Working Group meetings and attended other meetings organised by the Secretariat throughout the year as required.

Five partner meetings were held in total:

1. April 2017 in Cambridge, UK, hosted by JNCC
2. October 2017 in Athens, Greece, hosted by HCMR
3. May 2018 in Faro, Portugal, hosted by CCMAR
4. November 2018 in Brest, France, hosted by Ifremer
5. April 2019 in Rome, Italy, hosted by ISPRA

Meetings have been held with EMODnet Geology and EMODnet Biology throughout the year as required to discuss various areas of join up and overlap (namely for EMODnet Geology the delivery of their layers required as inputs into EUSeaMap and for EMODnet Biology the EMODnet Seabed Habitats contributions to the Atlas of Marine Life and the incorporation of seabed habitat data points into EuroBIS). A representative from EMODnet Bathymetry also attended our progress meeting in Brest, France in November 2018 to discuss the recently released DTM which also fed into the creation of EUSeaMap.

Communication

We developed a communications plan to help target publicity efforts. In June 2018 JNCC travelled to Ostend to meet with the Secretariat, to discuss communications activities and JNCC have represented EMODnet Seabed Habitats at the regular communications teleconferences organised by the Secretariat.

Some of the communications activities are listed below:

- Produced an updated EMODnet Seabed Habitats booklet outlining work completed to date and introducing the goals of the current phase of the project which all partners have been distributing at meetings and events;
- Attended many other meetings and events to promote the work of the project as outlined in Sections 8 and 9 of this report;
- Contributed to a peer reviewed paper on the use of EUSeaMap in supporting Ecosystem Based Management.
- Produced a series of promotional postcards to publicise the portal (Figure 9);
- Maintained contact and developed links with the various Regional Seas Conventions continuing discussions around join up and how EMODnet products could be further integrated into their work;
- Attended many other meetings and events to promote the work of the project as outlined in Sections 8 and 9 of this report, including JNCC's Science Director presenting on behalf of the whole EMODnet Consortium at the EOOS conference in Brussels in November 2018;

- Provided the required input into the initiatives of the Secretariat such as the EMODnet for Business campaign, the collation of user cases and the videos being developed to publicise each portal.



Figure 9: Promotional postcards. On the back it says "Find the answer to this and other questions at: www.emodnet-seabedhabitats.eu".

7 User Feedback

Note that it can be assumed that if the response time is less than around 1 hour then the question/comment came via the live chat service.

Date	Organization	Type of user feedback (e.g. technical, case study etc.)	Response time
21/03/2019	University of Barcelona	Case study: Professor at the University of Barcelona who teaches Benthic Habitat Mapping and would like to create a hands-on exercise to introduce EMODnet Seabed Habitats to my students. Wondered if we have any material to help e.g. a practical exercise to introduce EMODnet to already GIS-trained students. Would like to show the great possibilities of EMODNET by using our WMS services and develop their own GIS project fed with EMODnet data. JNCC suggested having a look at Use cases and WMS pages.	1 minute
15/01/2019	Water Insight (NL)	Technical: Asking whether we created our own WMS or used a third party provider.	30 seconds
13/12/2018	National University of Ireland Galway	Case study: needed information on observed or modelled biotope data from Irish territorial waters. Provided links to available data and relevant metadata (e.g. summaries, technical reports etc.).	21 days
29/11/2018	Not disclosed	Technical: User wanted PAR at surface which was not on the map viewer but was available to download	1 minute
26/11/2018	MBA	Suggestion: Re-add survey data from Marine Recorder to the EMODnet portal	
22/11/2018	Not disclosed	Technical: User wanted to select data by region	1 minute
22/11/2018	Orbis Ltd	Technical: User wanted to select data by region	1 minute
16/11/2018	ICES Fisheries Benthic Impact and Trade-offs (WGFBIT)	Technical: wanted information on how the MSFD layers are correlated from EUNIS to provide to members of an ICES working group. Provided relevant information and offered to show case ICES report on user cases when completed.	4 days
09/11/2018	Natural Resources Wales	Technical: user loaded UKSeaMap to their GIS application via WMS links, but some data wasn't showing. Advised it was likely due to the min/max viewing scales applied to the data. This solved the users problem.	45 minutes
02/11/2018	Muséum National d'Histoire Naturelle	Technical: user couldn't access EUSeaMap download in Arc Geodatabase due to missing drivers. Provided a customised Geoserver WFS link to download data by a selected region. Data was used to produce Skate distribution models in NE Atlantic waters.	1 day
29/10/2018	Not disclosed	Technical: User wanted assistance downloading EUNIS classification for the UK and import into QGIS	1 minute
18/10/2018	Not disclosed	Technical: User contacted the helpdesk for access to products and a co-ordinate grid to overlay on the interactive mapper	1 day
10/10/2018	Not disclosed	Technical: User contacted the helpdesk for access to products	1 day

Date	Organization	Type of user feedback (e.g. technical, case study etc.)	Response time
18/09/2018	Latitude GIS	Technical: User requesting information on the organisation to send UK data to for submission to EMODnet Seabed Habitats	1 minute
30/08/2018	IVL Swedish Environmental Research Institute	Technical: User contacted the EMODnet central helpdesk after reading a scientific paper and was looking for sediment distribution in the Baltic Sea – We were contacted by EMODnet secretariat and provided link to the Baltic EUSeaMap 2016 map.	1 day
28/08/2018	Intertek	Technical: Required ESRI symbology layer for EUSeaMap	1 minute
15/08/2018	Natural England	Technical: Issues with displaying WMS links	1 minute
Aug-18	Various (18 responses)	Survey response: received 18 responses to an online survey which we established to gather user feedback on our interactive map.	N/A
28/07/2018	Member of the public	Technical: Issue with viewing layers	2.5 days (came in over the weekend)
20/07/2018	Marine Biological Association	Technical: Suggestion for portal improvement	1 minute
12/07/2018	Cefas	Data provision: Where are UK Annex I reef layers available from	30 seconds
26/06/2018	EMODnet Secretariat	Technical: Broken metadata links on mapper	40 minutes
01/06/2018	EMODnet Secretariat	Technical: Various issues with the map viewer	1 minute
01/06/2018	EMODnet Secretariat	Suggestion: Would be useful to have a search function within the map layers to find things like mussel beds, without having to go through every layer manually	1 minute
28/05/2018	Not disclosed	Technical: Link in PDF booklet not working	3 minutes
23/05/2018	Not disclosed	Technical: Unable to view layers on Map Viewer	40 minutes
23/05/2018	MERC consultants	Technical: Link to metadata not working	1 minute
28/03/2018	European Environment Agency	Technical: suggestion for improving interoperability with WISE marine data service.	NA
07/03/2018	European Atlas of the Seas Steering Committee/ EMODnet Secretariat	Technical: suggestion for improving the speed and accessibility of the WMS/WFS services, to allow series monitoring and implement csw entry point.	NA
02/03/	Ghent	Data request: request for wave data in the Belgian continental shelf.	3

Date	Organization	Type of user feedback (e.g. technical, case study etc.)	Response time
2018	University		hours
26/02/2018	European Atlas of the Seas Steering Committee/ EMODnet Secretariat	Technical: issue with display of one of the layers and suggestion to use an url instead of an IP address and to hide the mapserver map file (directory path and folders, subfolders...) with help of a php wrapper.	22 hours
25/02/2018	European Atlas of the Seas Steering Committee/ EMODnet Secretariat	Technical: encoding of the characters.	21 hours
19/02/2018	EMODnet Secretariat	Technical: zoom function not working properly for one of the ESH interactive map layer.	3 hours
08/01/2018	University of East Anglia	Data request: request for full coverage NW EU continental shelf maps of several coastal/littoral habitats (saltmarsh, seagrass, kelp beds, intertidal mudflats, intertidal sandflats, maerl beds) to create carbon budget for the area.	2 hours
2018	BRGM (French Geological survey), responsible for MSFD descriptor 6 in France	Case study: EUSeaMap (EUNIS classification) v2016 used in assessment of MSFD descriptor 6 (sea-floor integrity) in French Mainland waters http://infoterre.brgm.fr/rapports/RP-67420-FR.pdf	N/A
2018	Universidade de Aveiro	Case study: EUSeaMap (EUNIS classification) v2016 used in a journal publication - Marine biological value along the Portuguese continental shelf https://www.sciencedirect.com/science/article/pii/S1470160X18303819#!	N/A
2018	Orsted	Case study: EUSeaMap (version 2016) used in an EIA for a windfarm project: Hornsea Project Three Offshore Wind Farm Environmental Statement: Volume 5, Annex 2.1 - Benthic Ecology Technical Report https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010080/EN010080-000572-HOW03_6.5.2.1_Volume%205%20-%202.1%20-%20Benthic%20Ecology%20Technical%20Report.pdf	N/A
2018	N/A	Case study: EMODnet seabed habitats portal is featured in the book "Exploring Britain's hidden world. A natural history of Seabed Habitats." Wild nature Press 2018. It is mentioned in the chapter "Technology takes off" as one of the to go places to find information on habitats distribution in the UK. https://www.nhbs.com/exploring-britains-hidden-world-book	N/A
2018	Comitato Capitale Naturale (Italian natural capital	Case study: EUSeaMap (version 2016, Mediterranean) was used in their assessment of the state of natural capital in Italy.	N/A

Date	Organization	Type of user feedback (e.g. technical, case study etc.)	Response time
	committee)		
2018	HCMR/Minien	Case study: EUSeaMap 2 used for the updates of the initial assessment of MSFD in Greece (implementation of Article 17 of MSFD) http://www.ypeka.gr/LinkClick.aspx?fileticket=bW4BrJKUMWs%3d&tabid=232&language=el-GR	N/A
2018	SHOM (National Hydrographic Service, France)	Case study: EUSeaMap 2017 used in assessment of MSFD descriptor 7 (Hydrographical conditions) in French Mainland waters. Tew-Kai, E., Cachera, M., Boutet, M., Cariou, V., Le Corre, F., 2018. Évaluation du descripteur 7 « Conditions hydrographiques » en France métropolitaine. Rapport scientifique pour l'évaluation 2018 au titre de la DCSMM, 747 p. (Not yet available online)	N/A
2018	Department of Housing, Planning and Local Government, Ireland	Case study: EUSeaMap 2017 used to assess extent of marine habitats to contribute to national marine planning framework development in Ireland https://www.housing.gov.ie/sites/default/files/publications/files/national_marine_planning_framework_baseline_report.pdf	N/A
2018	Minouw Project	Case study: EMODnet Seabed Habitats substrate and bathymetry data used in a report on spatial estimates of "Fisheries footprint" on different substrate and bathymetry http://minouw-project.eu/	N/A
28/09/2017	ISMAR-CNR	Technical: this user had previously enquired about the adoption of CC-BY 4.0 license on EMODnet products. He was informed that EMODnet Seabed Habitats had moved to the license for all portal-made products. He provided positive feedback on the license adoption and suggested it be used in wider EMODnet.	NA
06/09/2017	SYKE	Technical: one partner suggested the ability to drag layers on the map's table of contents to determine drawing order. Suggestion added to development options, but is currently not feasible.	NA
Sep-17	EMODnet Check-points	Case studies: We have reviewed all the EMODnet Checkpoint Data Adequacy Reports and compiled a list of relevant points. For each point, we have identified an action.	NA
2016-2017	Freshwater Ecosystem Services Mapping and Assessment in Bulgaria (FEMA), funded by EEA Financial Mechanism 2009-2014	Case study: Assessment and mapping of the ecosystem types, ecological state and ecosystem services in the Bulgarian Black Sea. Used EUSeaMap (EUNIS classification) v2016 - Black Sea http://www.freshwater-ecoservices-bg.eu/images/fema_docs/presentations/20170331_08_FEMA-MARE-Karamfilov_et_al.pdf	N/A
01/06/2017	SGU	Future product suggestion: add a feature to the portal that would allow anyone to produce their own 'EUSeaMap' using their own data. (in discussion at ICES WGMHM)	NA

Date	Organization	Type of user feedback (e.g. technical, case study etc.)	Response time
01/06/2017	AWI	Future product suggestion: add tools to the portal to allow people to analyse the data in different ways, e.g. some basic spatial statistics. (in discussion at ICES WGMHM)	NA
12/05/2017	burdGIS	General portal feedback (unsolicited): "A fantastic seabed habitat datasource courtesy of EMOD"	NA
Jan-17	NA	General portal feedback: we signed our website up to http://peek.usertesting.com/ which uses members of the public to provide feedback on a website via a 5-minute screencast.	NA
2017	SimCelt habitat	Case study - They presented EUSeaMap as the best source of data on Marine Habitats for the Celtic Seas region for the purposes of Maritime Spatial Planning.	NA
2017	Adriplan project	Case study - EUSeaMap used in a cumulative impact assessment for the Adriatic Sea – presented through a data portal and peer review publications	NA
2017	Danish Agriculture and Food Council	Case study: EUSeaMap used in a report to estimate and map potential cumulative impacts in Danish marine waters https://www.researchgate.net/publication/319392413_Under_the_surface_A_gradient_study_of_human_impacts_in_Danish_marine_waters	N/A
2017	Norwegian Institute for Water Research	Case study: EMODnet model for light (PAR) used in a report on climate adaption, CO2 uptake, and sequestration of carbon in Nordic blue forest https://brage.bibsys.no/xmlui/handle/11250/2478099	N/A
2016	OSPAR	Case study – They combined the products (EUSeaMap and EUNIS habitat maps from surveys) into a single layer, attached sensitivity information to it and overlaid with human activity data to assess the "Extent of Physical Damage to Predominant and Special Habitats", which is an OSPAR common indicator which is being used to inform against the MSFD criteria D1.6 - Habitat condition and D6.1 - Physical damage, having regard to substrate characteristics	NA
2016	JRC	Case study: EUSeaMap (EUNIS classification) v 2016 used in assessment of spatial distribution of marine ecosystem service capacity in the European seas https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/spatial-distribution-marine-ecosystem-service-capacity-european-seas	N/A
2016	Instituto da Conservação da Natureza e das Florestas (ICNF)	Case study: EUSeaMap used to assess the extent of habitats within Portuguese MPAs and Strategic Environmental Assessment http://www2.icnf.pt/portal/icnf/instrum-gest/resource/doc/pa/PA-2016-v2Final-20160615.pdf	N/A
Ongoing	General Administration of Natural Resources, Maritime Security and Services	Case study: Used on the Maritime Area Planning Geoportal for Marine Spatial Planning in Portuguese waters http://webgis.dgrm.mam.gov.pt/arcgis/apps/webappviewer/index.html?id=df8accb510bc4f33963d9b03bf3674b8	N/A

Date	Organization	Type of user feedback (e.g. technical, case study etc.)	Response time
	(DGRM), Portugal		

8 Meetings held/attended

Table 4: Meetings in Year 1 (different reporting format so couldn't merge tables easily).

Date	Location	Title	Internal/External + Short Description
18-20/04/2017	Cambridge, UK	EMODnet Seabed Habitats Partner Meeting	Internal – Kick off meeting with partners for EMODnet Seabed Habitats Phase 3
25-26/04/2017	Ostend, Belgium	EMODnet Biology Kick Off Meeting	Internal – Attended meeting to establish links and introduce the Seabed Habitats project
30/05/2017	Copenhagen, Denmark	ICES Habitat Mapping Working Group	External – Presented on EMODnet Seabed Habitats (previous achievements and plans for this phase), asked for feedback on the portal and started discussions on how to better align EMODnet SH with the ICES WGMHM
30-31/05/2017	Espoo, Finland	EMODnet Geology Kick Off Meeting	Internal – Attended meeting to establish links and introduce the Seabed Habitats project
07/06/2017	Copenhagen, Denmark	ETC-ICM, Technical Group – Data (TGDATA)	External – Provided EMODnet Seabed Habitat slides for a presentation giving an overview of all EMODnet data and metadata standards in relation to MSFD reporting.
06/07/2017	Teleconference	WP2 meeting	Internal – To debate the integration in the broad-scale map existing survey data polygons on biogenic habitats
13-15/09/2017	Rome, Italy	EMODnet Steering Committee	Internal – JNCC represented EMODnet Seabed Habitats at the meeting
18/09/2017	Toulouse, France	Meeting with Mercator Ocean	External – presented the requirements of the Seabed Habitats project for Copernicus products and stated our willingness to collaborate
02/10/2017	Athens, Greece	Meeting with EMODnet Geology	Internal - JNCC and GTK (EMODnet Geology coordinator) discussed various points of common interest between the projects.
03-06/10/2017	Athens, Greece	EMODnet Seabed Habitats Partner Meeting	Internal – Second EMODnet Seabed Habitats Partner Meeting
10/10/2017	London, UK	EMODnet Biology Essential Data Products Workshop	Internal - presented the EMODnet Seabed Habitats project, its links with EMODnet Biology and its ambitions/possibility regarding the development of data products.
30-31/10/2017	Redlands, California, USA	Ecological Coastal Units Project Workshop	External - presented EUSeaMap and the EUNIS habitat classification and contributed to the definition of the objectives and methods for defining these ECUs based on our experiences and knowledge of marine classification approaches, potential issues and data availability.
08-09/11/2017	Bergen, Norway	Atlantic Seabed Mapping International Working Group	External - presented the EMODnet Seabed Habitats portal and make proposals for interoperability with their data and their North Atlantic Data Viewer .

		Seabed Mapping Workshop	
14-17/11/2017	Antwerp, Belgium	EMODnet Open Sea Lab	Internal – represented EMODnet Seabed Habitats at the meeting
05/12/2017	Gothenburg, Sweden	OSPAR ICG-COBAM Data Flows Workshop	External - promoted the services that the project can offer in streamlining data flow into these indicator assessments.
20/02/2018	London, UK	Seabed Mapping Working Group	External – UK habitat mapping group of various organisations with a seabed habitat mapping remit throughout the UK. JNCC attended and highlighted EMODnet work as relevant.
26/02/2018	Edinburgh, UK	MAREMAP	External – UK meeting on co-ordinated effort to map seafloor geology. JNCC attended workshop and highlighted EMODnet work as relevant.
26/02/2018	Teleconference	WP2 Progress Meeting	Internal – Updates on thresholds, milestones and actions
20-21/02/2018	Mallorca, Spain	EMODnet Technical Working Group	Internal – JNCC represented EMODnet Seabed Habitats at the meeting
21-23/02/2018	Mallorca, Spain	EMODnet Steering Committee	Internal – JNCC represented EMODnet Seabed Habitats at the meeting
14/03/2018	Marine Institute, Ireland	COMPASS Project Modelling Workshop	External EU Project meeting. Presentation 'Ireland's Seabed Mapping Programme' with EMODnet participation slides.
11-12/04/2018	Varna, Bulgaria	WP2 Meeting	Internal – To assess the Black Sea broad-scale seabed habitat map and brainstorm on solutions to issues
24/04/2018	London, UK	MEDIN 10 Year Meeting	External – Discussions with other meeting attendees about progress with EMODnet Seabed Habitats
03-04/05/2018	Trieste, Italy	EMODnet Biology Meeting	Internal – To maintain links and co-ordination between EMODnet Biology and Seabed Habitats, particularly in relation to WP4 ground truthing.

Table 5: Meetings in Year 2 (different reporting format so couldn't merge tables easily).

Date	Location	Type event (meeting, training (workshop), etc.)	Attended (A) / Organised (O)	Short description and main results (# participants, agreements made, etc.)
22-24/05/2018	Hamburg, Germany	Meeting/Workshop: ICES Working Group on Marine Habitat Mapping	A	Meeting focussed on confidence in habitat mapping. Considered links between ICES WGMHM and EMODnet Seabed Habitats and if/how these could be improved.
28-31/05/2018	Faro, Portugal	Meeting: EMODnet Seabed Habitats Partner Meeting	O	Meeting of 12 partners to discuss work completed in Year 1 of the project and plans for Year 2.
06-07/06/2018	Ostend, Belgium	Meeting: Bilateral meeting with EMODnet Secretariat	O	Attended Ostend to meet with the EMODnet Secretariat to discuss plans for EMODnet Seabed

Date	Location	Type event (meeting, training (workshop), etc.)	Attended (A) / Organised (O)	Short description and main results (# participants, agreements made, etc.)
				Habitats with a particular focus on communications and outreach.
07/06/2018	Ostend, Belgium	Meeting: Bilateral meeting with EMODnet Biology	O	Met with EMODnet Biology leaders in Ostend to discuss areas of common interest between the two portals, in particular ground truthing data points and submission to EuroBIS, collation of data from third parties, species and habitat distribution modelling and the Data Products Workshops.
13/06/2018	Santander, Spain (joined remotely from UK)	Meeting: OSPAR ICG-COBAM	A	Invited to attend the OSPAR ICG-COBAM meeting to discuss how EMODnet can help deliver data layers to assist with their habitat assessment requirements.
10/09/2018	Skype	Meeting: WP4 – data upload on internal portal	O	Discussion on the best way to upload and make available data collected within WP4 on the seabed habitats portal
13/09/2018	Skype	Meeting: WP2 - Barents Sea	O	Discussions over how to extend EUSeaMap to the Barents Sea
18-19/09/2018	Vaasa, Finland	Seminar: Gulf of Bothnia change	A	Discussed the possibilities of using the EMODnet habitat data in optimisation of windfarm sites
01-02/10/2018	Brussels, Belgium	EMODnet Technical Working Group	A	Representing EMODnet Seabed Habitats at the TWG
08-10/10/2018	Oostende, Belgium	Workshop: EMODnet Biology Products Workshop	A	Discussing the three Essential Ocean Variables which EMODnet Seabed Habitats will be contributing to the Atlas of Marine Life
31/10/2018	Skype	Meeting: EUSeaMap – Modelling the Barents Sea	O	Meeting between relevant EMODnet Seabed Habitat partners, NGU (EMODnet Geology partners) and IMR (EMODnet Biology partners) to discuss the approach that should be taken to map the seabed habitats in the Barents Sea
13-15/11/2018	Brest, France	Meeting: EMODnet Seabed Habitats Partner Meeting	O	Discussing the work remaining to complete tasks within this phase of the project
16/11/2018	Brest, France	Workshop: EUSeaMap workshop	O	Workshop to discuss the new process for running the EUSeaMap model
19-20/11/2018	Brussels, Belgium	Meeting: EMODnet Steering Committee	A	Representing EMODnet Seabed Habitats at the Steering Committee meeting

Date	Location	Type event (meeting, training (workshop), etc.)	Attended (A) / Organised (O)	Short description and main results (# participants, agreements made, etc.)
15/01/2019	Skype	Meeting: WP2 meeting (internal)	O	Broadscale habitat map progress and updates
17/01/2019	Skype	Meeting: EMODnet Biology/Seabed Habitats bilateral meeting	O	Discussing collaboration between the Lots, in particular the three Essential Ocean Variables which EMODnet Seabed Habitats is contributing to the Atlas of Marine Life
28/01/2019	Skype	Meeting: WP5 meeting (internal)	O	Composite products
05/02/2019	Skype	Meeting: WP5 meeting (internal)	O	Composite products and library of habitat maps
07/02/2019	Skype	Meeting: WP2 meeting (internal)	O	Broadscale habitat map progress and updates
06/03/2019	Skype	Meeting: WP2 meeting (internal)	O	Broadscale habitat map in the Barents Sea
28/03/2019	Peterborough, UK	Meeting: Bilateral meeting between JNCC and the UK Hydrographic Office	O	Aim to build a partnership that would start with a future workshop/hackathon between JNCC and UKHO
02-04/04/2019	Rome, Italy	Meeting: EMODnet Seabed Habitats Partner Meeting	O	Discussing the work remaining to complete tasks within this phase of the project and possible ideas for the future phase
15/05/2019	Lisbon, Portugal	Workshop: EMODnet Biology End User Workshop	A	Presenting on the GOOS EOVS composite layers created by EMODnet Seabed Habitats which have also fed into EMODnet Biology's Atlas of Marine Life
16-17/05/2019	Lisbon, Portugal	Meeting: EMODnet Biology Partner Meeting	A	Representing EMODnet Seabed Habitats at the EMODnet Biology Partner Meeting
03-07/06/2019	Mallorca, Spain	Meeting/Workshop: ICES Working Group on Marine Habitat Mapping	A	Presenting on the EMODnet Seabed Habitats portal and data products at the ICES Working Group on Marine Habitat Mapping
SUM			O	Total # of meetings organised = 16 (year 2 only)
SUM			A	Total # of meetings attended = 9 (year 2 only)

9 Outreach and communication activities

Table 6: Communication activities in Year 1 (different reporting format so couldn't merge tables easily).

Date	Media	Title	Short description and/or link to the activity
01-05/05/2017	Leaflet distributed at Geohab	The EMODnet Seabed Habitats Portal: Your one-stop shop for seabed habitat data	Leaflet distributed at Geohab conference in Halifax, Canada - http://geohab2017.wixsite.com/geohab2017
15/06/2017	Presentation at RDA-Europe BlueBRIDGE Datathon on Fisheries and Aquaculture	EMODnet Seabed Habitats	Invited to present an overview of the datasets and tools available that could be useful during the datathon. Presentation given remotely via GoToMeeting - http://www.bluebridge-vres.eu/events/rda-europe-bluebridge-datathon-fisheries-and-aquaculture-june-15-16-heraklion-crete-greece
11/07/2017	Poster presentation at M2D - Models to Decisions annual conference	Confidence in the EMODnet Broad-Scale Seabed Habitat Map for Europe	Poster presentation on confidence assessment in EMODnet SH broad-scale map at a conference on communicating uncertainties in modelling to decision makers. Conference organised by the M2D network - http://blogs.exeter.ac.uk/models2decisions/events/m2d-2017-annual-conference/
15-16/11/2017	Presentation at INFOMAR National Seabed Mapping conference	EMODnet regional data products	Presentation at INFOMAR National Seabed Mapping conference in Ireland on EMODnet regional data products - http://www.infomar.ie/documents/INFOMAR_2017_Seminar_Agenda.pdf
10-12/01/2018	Presentation at Nordic Geological Winter Meeting	EMODnet seabed habitats. The Danish contribution.	Presentation by GEUS on EMODnet Seabed Habitats at the Nordic Geological Winter Meeting - http://2dqf.dk/foreningen/33rd-nordic-geological-winter-meeting/
10/02/2018	Peer reviewed paper published in Open Journal of Ecology	European Broad-Scale Seabed Habitat Maps Support Implementation of Ecosystem-Based Management	Project members contributed to the publication of a paper on the use of EUSeaMap in supporting Ecosystem Based Management. The paper is available online at: http://file.scirp.org/Html/2-1380880_82460.htm
20-22/03/2018	Presentation at Merigeo	EMODnet: tour d'horizon	Presentation by Ifremer on EMODnet at Merigeo - http://www.merigeo.fr/
27/03/2018	Presentation at MAREANO INFORMAR and MAREMAP	Automated Marine Habitat Classification Techniques	Presentation by the Marine Institute at the MIM working group on seabed substrate mapping including information on EMODnet

	(MIM) working group		
05/2018	Leaflet updated for use in Year 2	The EMODnet Seabed Habitats Portal: Your one-stop shop for seabed habitat data	EMODnet Seabed Habitats leaflet has been updated to include work completed and plans for Phase 3 for use to publicise the portal at events in Year 2 of the project.

Table 7: Communication activities in Year 2 (different reporting format so couldn't merge tables easily).

Date	Communication action/material	Short description (of the material, title, ...) and/or link to the activity	Main results (# participants, # views, # press clippings, etc.)
08/05/2018	Oral presentation	Presentation on Infralittoral/Circalittoral biozone boundary definition in a riverine input influenced area at GeoHab, California USA	
08/05/2018	Poster presentation	Poster on A New EMODnet Seabed Habitat Product: Ground-Truth Data Collection at GeoHab, California USA	
03/06/2018	Oral presentation	Presentation on EMODnet Seabed Habitats: A European broad-scale seabed habitat map at 12th Panhellenic Symposium of Oceanography and Fisheries, Corfu, Greece	
05/06/2018	Poster presentation	Poster on EUSeaMap - A Pan European Seabed Habitats Cartography: Evolution and Perspective at 49° Congresso. della Società Italiana di Biologia Marina	
08/06/2018	Oral presentation	Presentation on the EMODnet Seabed Habitats data portal at EMODnet Italia Day, Trieste, Italy	
26-27/06/2018	Poster presentation	Poster on the EMODnet Seabed Habitats Portal at Beyond the Coast, Hull, UK	
08/18	Online survey	Running an online survey to capture user feedback on our web mapper	18 responses. Generally positive feedback, some areas to think about for development/improvement.
18-21/09/18	Networking	Attended the INSPIRE conference.	Networking and learning opportunity to discuss EMODnet Seabed Habitats.
10/10/2018	Oral presentation	EUSeaMap overview at the Black Sea 2018 International Conference	
18/10/2018	Oral presentation	Talk on Marine Mapping at an environmental conference in Norway which included information on the EMODnet light (PAR) model, Trondheim, Norway	
05-07/11/2018	Poster presentation	Poster on the EMODnet Seabed Habitats portal at the IMDIS conference, Barcelona, Spain	Approximately 200 participants

Date	Communication action/material	Short description (of the material, title, ...) and/or link to the activity	Main results (# participants, # views, # press clippings, etc.)
09/11/2018	Oral presentation	EMODnet overview at the INFOMAR annual seabed mapping seminar	
21/11/2018	Oral presentation	Presentation on how academia is preparing the future workforce for Blue Growth worldwide, with a focus on habitat mapping using EuSeaMap and EMODnet at the Academia For The Ocean - European Parliament event in Brussels	
21-23/11/2018	Oral presentation	Oral presentation on the creation of EUSeaMap and the collaboration of the EMODnet consortium at the EOOS conference	Approximately 350 participants
03/12/2018	Oral presentation	EMODnet overview given at JNCC/Marine Scotland bilateral meeting	Increased awareness of the EMODnet project and outputs within the Scottish Government
23/01/2019	Poster presentation	Presenting EMODnet as a project and concentrating on the Lots that Denmark is contributing in at the 20th Marine Sea Searchers meeting in Odense, Denmark	350 participants
25/01/2019	Oral presentation	Talk on marine habitat, biodiversity and fisheries mapping for Marine Spatial Planning at a conference on Marine Biology - A bridge between seas, Faro, Portugal	
30-31/01/2019	Oral presentation	Talk on the limitations of predicting substrate classes on a sedimentary complex but morphologically simple seabed at MIM Working Group on Seabed Substrate Mapping, NGU, Trondheim, Norway	
14/02/2019	Oral presentation	Talk on habitat mapping products for Marine Spatial Planning at a meeting on MSP data availability in Galway, Ireland	20 people split into smaller themed groups of 4-6 people
19/03/2019	Oral presentation	Presenting project on facilitating the dissemination of EMODnet seabed habitat data to end users at the UK Government Data Science Accelerator Graduation event, London, UK	50 participants
23/03/2019	Oral presentation	Presentation of several mapping approaches including the use of EUNIS and EMODnet in the first congress of the municipalities of SW Portugal, Lagos at the first congress of the Infante's Land, Lagos, Portugal	
08-09/05/2019	Oral presentation	Presentation on Broad-scale circalittoral soft-bottom benthic habitats at the Romanian Black Sea Coast at the Sustainable Development at the Black Sea - SUST-BLACK Conference, Bucharest, Romania	
13-17/05/2019	Poster & oral presentation	Poster on the EMODnet Seabed Habitats portal at GeoHab in St Petersburg, Russia	
05/2019	Publicity postcards produced	A series of five postcards promoting the EMODnet Seabed Habitats portal have been produced.	250 have been printed of each design.

Date	Communication action/material	Short description (of the material, title, ...) and/or link to the activity	Main results (# participants, # views, # press clippings, etc.)
SUM		Total # of networking occasions (both years)	1
SUM		Total # of oral presentations (both years)	22
SUM		Total # of poster presentations (both years)	6
SUM		Total # of survey responses (both years)	18
SUM		Total # of leaflets & postcards (both years)	7
SUM		Total # of peer reviewed papers (both years)	1

Table: List of known publications using EMODnet data or data products.

Date	Name of journal, conference, ...	Publication title	Authors	Organisation(s)
2016	ICES Journal of Marine Science	Towards a framework for the quantitative assessment of trawling impact on the seabed and benthic ecosystem	A. D. Rijnsdorp F. Bastardie S. G. Bolam L. Buhl-Mortensen O. R. Eigaard K. G. Hamon J. G. Hiddink N. T. Hintzen A. Ivanović A. Kenny P. Laffargue J. R. Nielsen F. G. O'Neill G. J. Piet H. Polet A. Sala C. Smith P. D. van Denderen T. van Kooten M. Zengin	IMARES, Technical University of Denmark, Cefas, Institute of Marine Research, LEI Wageningen, University of Aberdeen, Bangor University, Ifremer, Marine Scotland Science, Institute for Agricultural and Fisheries Research, CNR, Hellenic Centre for Marine Research, Central Fisheries Research Institute
2016	Marine Pollution Bulletin	Reducing spatial variation in environmental assessment of marine benthic fauna	Kjell Leonardsson, Mats Blomqvist, Rutger Rosenberg	Swedish University of Agricultural Sciences, Hafok AB, Marine Monitoring AB, Kristineberg, University of Gothenburg
2017	Science of the Total Environment	Spatially explicit risk approach for multi-hazard assessment and management in marine environment: The case study of the Adriatic Sea	Elisa Furlan, Silvia Torresan, Andrea Critto, Antonio Marcomini	University Ca' Foscari Venice, Fondazione Centro Euro-Mediterraneo sui Cambiamenti Climatici (Fondazione CMCC)
2018	Global Change Biology	Assessing the sensitivity of bivalve populations to global warming using an individual-based modelling approach	Yoann Thomas, Cedric Bacher	Institut Universitaire Européen de la Mer (IUEM), Ifremer
2018	Ecological Indicators	EUSEaMap (EUNIS classification) v2016 used in a journal publication - Marine biological value along the Portuguese continental shelf https://www.sciencedirect.com/science/article/pii/S1470160X18303819#!	Inês Gomes, Sergi Pérez-Jorge, Laura Peteiro, Joana Andrade, Juan Bueno-Pardo, Víctor Quintino, Ana Maria Rodrigues, Manuela Azevedo, Ann Vanreusel, Henrique Queiroga, Klaas Deneudt	Aveiro University, Ghent University, University of the Azores, Vigo University, SPEA, IPMA, Flanders Marine Institute
2018	Ambio	Effects of an invasive polychaete on benthic phosphorus cycling at sea basin scale: An ecosystem disservice	Sandman AN, Näslund J, Gren IM, Norling K.	AquaBiota Water Research, Department of Economics, Swedish University of Agricultural Economics, Swedish Agency for Marine and Water Management
2018	Aquatic Conservation: Marine and Freshwater Ecosystems	Morpho-demographic traits of two maërl-forming algae in beds with different depths and fishing histories	Miguel Cabanellas-Reboredo, Sandra Mallol, Carmen Barberá, Alba Vergés, David Díaz, Raquel Goñi	Instituto Español de Oceanografía, Centro Oceanográfico de Baleares, GRMAR, Institut d'Ecologia Aquàtica, Universitat de Girona

2018	Ecological Indicators	Marine biological value along the Portuguese continental shelf; insights into current conservation and management tools	Inês Gomes, Sergi Pérez-Jorge, Laura Peteiro, Joana Andrade, Juan Bueno-Pardo, Victor Quintino, Ana Maria Rodrigues, Manuela Azevedo, Ann Vanreusel, Henrique Queiroga, Klaas Deneudt	University of Aveiro, Ghent University, University of Azores, University of Vigo, Sociedade Portuguesa para o Estudo das Aves (SPEA), Instituto Português do Mar e da Atmosfera (IPMA), Flanders Marine Institute (VLIZ)
2018	Animal Biotelemetry	A review of acoustic telemetry in Europe and the need for a regional aquatic telemetry network	David Abecasis, Andre Steckenreuter, Jan Reubens, Kim Aarestrup, Josep Alós, Fabio Badalamenti, Lenore Bajona, Patrick Boylan, Klaas Deneudt, Larry Greenberg, Niels Brevé, Francisco Hernández, Nick Humphries, Carl Meyer, David Sims, Eva B. Thorstad, Alan M. Walker, Fred Whoriskey and Pedro Afonso	University of the Algarve, University of the Azores, Flanders Marine Institute (VLIZ), DTU, Instituto Mediterráneo de Estudios Avanzados (CSIC-UIB), CNR-IAMC, Dalhousie University, Loughs Agency, Karlstad University, Sportfisserij Nederland, The Marine Biological Association of the U.K, Hawai'i Institute of Marine Biology, University of Southampton, Norwegian Institute for Nature Research (NINA), Centre for Environment, Fisheries and Aquaculture Science (Cefas)
2019	Plos One	Spatial variation in a top marine predator's diet at two regionally distinct sites	Martha Gosch, Michelle Cronin, Emer Rogan, William Hunt, Cian Luck, Mark Jessopp	University College Cork
2019	Science of the Total Environment	Ecosystem damage from anthropogenic seabed disturbance: A life cycle impact assessment characterisation model	John S Woods, Francesca Verones	Industrial Ecology Programme, Norwegian University of Science and Technology

10 Updates on Progress Indicators

Progress indicators are provided according to the new template in the accompanying Excel file entitled *1905_EMODnet_FinalReport_SeabedHabitats.xlsx*.

11 Recommendations for follow-up actions by the EU

Future of EMODnet

EMODnet is providing a valuable data repository which is becoming increasingly used by Member States and the EEA, but its uptake would be strengthened by removing any perception it is a time-limited project by member states, by formally endorsing it as a permanent resource.

Data structures and data products

There are overlaps and areas of common interest between EMODnet and the EEA (and the European Topic Centres) and the recent dialogue on finding common data structures and products should be encouraged and extended to ensure that data products required for indicators and assessments are given a solid European footing. This will also help Member States by reducing their reporting load and effort in developing data flows.

Enforcement of the release of publicly funded datasets

Increased enforcement of the release of publicly funded datasets would be helpful in allowing us to collate them for EMODnet and wider dissemination. COCONET and MediSeH are examples of EU funded projects where the data should be readily available but are hard to access.

Implementation of new EUNIS

Increased funding and support to facilitate the implementation of the newly updated EUNIS classification so that it could be formally adopted would be beneficial.

Extension of the area of EMODnet coverage

We have had feedback from those working within the OSPAR Intersessional Correspondence Group on Marine Protected Areas (OSPAR ICG-MPA) that EMODnet products would be more useful to them if they covered the full OSPAR area. A slight extension to the EMODnet area of coverage to account for this would help improve integration with OSPAR.

Updates to the INSPIRE geoportal editor

Many partners have had difficulty producing INSPIRE-compliant metadata for the map collation process. We have found that metadata created on the INSPIRE geoportal editor does not pass its own validation test. Therefore the creation of metadata has had to be manually repeated by the workstream lead for almost all of the maps collated. This process could be avoided in the future if the INSPIRE Editor online was upgraded and maintained so the resulting metadata it creates passed the online validation test.

Addition of habitats of interest to the Regional Sea Conventions to the INSPIRE data specification

We would like to see habitats of interest to the Regional Sea Conventions added to the INSPIRE data specification (e.g. OSPAR Threatened and Declining Habitats).

More money and focus on INSPIRE to improve user-friendliness

We would like to see more money and focus on INSPIRE to drive its usability for ordinary scientists. This would include simpler documentation and tools which enable users to best use INSPIRE data. We believe this would promote its use amongst the EU scientific community.

12 Annex: Other documentation attached

12.1 Annex I: List of expected modelled Black Sea broad scale habitats, respective environmental variables necessary for their modelling and included assemblages – Version 04/2018

Broad scale habitat name	Biological Zone	Substrate	Temperature	Bathymetry	Density (sigma-theta)	Contains indicator association
Infralittoral sand (Plume)	INFRA	SAND	Biological zones are defined based on the type of substrate IF SAND or MUDDY SAND -> INFRA ELSE -> CIRCA			Fine sand with <i>Lentidium mediterraneum</i>
Infralittoral muddy sand (Plume)	INFRA	MUDDY SAND				<i>Cerastoderma glaucum</i> , <i>Mya arenaria</i> , <i>Anadara kagoshimensis</i>
Circalittoral coarse and mixed sediment (Plume)	CIRCA	MIXED/COARSE				Diverse faunal assemblages due to heterogeneous substrate dominated by bivalves <i>Mytilus galloprovincialis</i> , <i>Spisula subtruncata</i> , <i>Acanthocardia paucicostata</i> and polychaetes <i>Nephtys hombergii</i>
Circalittoral terrigenous muds (Plume)	CIRCA	MUD/ SANDY MUD				Danube and Dnieper plume areas (Mud with <i>Melinna palmata</i> , <i>Mya arenaria</i> , <i>Alitta succinea</i> , <i>Nephtys hombergii</i>)

Infralittoral rock	INFRA	ROCK		<14m To be revised	<p>Upper-infralittoral rock dominated by <i>Cystoseira bosphorica</i></p> <p>Upper-infralittoral rock dominated by <i>Cystoseira barbata</i></p> <p>Upper infralittoral rock with variable annual green and red macroalgae <i>Ceramium virgatum</i>, <i>Gelidium spinosum</i>, <i>G. crinale</i>, <i>Corallina mediterranea</i>, <i>Ulva rigida</i>, <i>Ulva linza</i>, <i>U. intestinalis</i>, <i>Cladophora sericea</i>, <i>C. albida</i>, <i>Bryopsis plumosa</i></p> <p>Lower infralittoral rock with dominant perennial sciaphylic red and brown macroalgae (<i>Phyllophora crispa</i>, <i>Zanardinia typus</i>, <i>Apoglossum ruscifolium</i>) and/or widely adaptive green (<i>Cladophora albida</i>, <i>Cladophora coelothrix</i>) and red macroalgae (<i>Polysiphonia elongata</i>, <i>Gelidium spinosum</i>, <i>Gelidium crinale</i>, <i>Anithamniom cruciatum</i>)</p> <p>Infralittoral rock overgrown by <i>Mytilaster lineatus</i> and <i>Mytilus galloprovincialis</i></p> <p>Infralittoral soft rock with piddocks (<i>Pholas dactylus</i>, <i>Barnea candida</i>)</p> <p>Infralittoral rock with faunal turf (bryozoans, sponges)</p> <p>Biogenic reefs of <i>Ostrea edulis</i></p> <p>Upper infralittoral rock with photophilic macroalgae (<i>Ceramium virgatum</i>, <i>Corallina officinalis</i>, <i>Ulva rigida</i>, <i>Ulva linza</i>, <i>U. intestinalis</i>, <i>Cladophora vagabunda</i>, <i>Cladophora sericea</i>, <i>C. albida</i>, <i>Bryopsis plumosa</i> and <i>Cystoseira barbata</i>)</p> <p>Infralittoral rock with <i>Mytilaster lineatus</i> and <i>Mytilus galloprovincialis</i></p>
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						Infralittoral soft rock with Pholadidae Lower infralittoral rock with faunal turf (sponges)
Circalittoral rock	CIRCA	ROCK		>14m To be revised		Mussel beds of <i>Mytilus galloprovincialis</i> on varied circalittoral sediment Circalittoral rock overgrown by <i>Mytilus galloprovincialis</i> , hydrozoans and sponges
Infralittoral Coarse and Mixed Sediment	INFRA	COARSE; MIXED		<19m		Infralittoral shelly gravel and sand with <i>Chamelea gallina</i> and <i>Mytilus galloprovincialis</i>
Infralittoral sand and muddy sand	INFRA	SAND; MUDDY SAND		<19m		Pontic <i>Zostera noltii</i> meadows Pontic mixed <i>Zostera noltii</i> - <i>Zannichellia palustris</i> - <i>Zostera marina</i> meadows Pontic <i>Zostera marina</i> meadows Pontic <i>Potamogeton pectinatus</i> - <i>Zannichellia palustris</i> meadows in man-made sheltered areas Upper-infralittoral medium and fine sand dominated by <i>Donax trunculus</i> Infralittoral shelly coarse sand and shellbed with varied infauna Infralittoral fine and medium sand, dominated by <i>Chamelea gallina</i> (<i>Lentidium mediterraneum</i> , <i>Tellina tenuis</i>) Lower infralittoral coarse and medium sand, dominated by <i>Upogebia pusilla</i>

						<p>Infralittoral fine sand dominated by <i>Lentidium mediterraneum</i> (<i>Cerastoderma glaucum</i>)</p> <p>Lower infralittoral muddy sand with <i>Upogebia pusilla</i></p>
Shallow circalittoral shelly coarse sediment	CIRCA	COARSE (shelly with no mud)	>9.7°C	>19m		<p><i>Coccotylus truncatus</i> & <i>Phyllophora crispa</i> on shelly organogenic sand</p> <p>Shallow circalittoral shelly coarse sediment with varied infauna (<i>Modiolus adriaticus</i>, <i>Gouldia minima</i>)</p> <p>Shallow circalittoral shelly coarse sediment with varied infauna (<i>Nereididae</i>, <i>Diogenes pugilator</i>, <i>Polititapes aureus</i>, <i>Pitar rudis</i>, <i>Mytilus beds</i>)</p>
Shallow circalittoral mud	CIRCA	MUD; SANDY MUD; MUDDY SAND	>9.7°C	>19m		<p>Shallow circalittoral muddy sand and sandy mud with <i>Upogebia pusilla</i>, <i>Heteromastus filiformis</i>, <i>Nephtys hombergii</i>, <i>Aricidea claudiae</i>, <i>Chamelea gallina</i></p> <p>Shallow circalittoral mud dominated by <i>Melinna palmata</i></p> <p>Shallow circalittoral sandy mud and mud with <i>Pitar rudis</i>, <i>Spisula subtruncata</i>, <i>Paphia aurea</i>, <i>Mytilus galloprovincialis</i>, <i>Abra spp.</i>, <i>Cardiidae</i>, <i>Nephtys hombergii</i>, <i>Heteromastus filiformis</i></p> <p>Shallow circalittoral mud and sandy mud with <i>Upogebia pusilla</i> (up to 30m depth)</p> <p>Shallow circalittoral mud with <i>Abra nitida</i>, <i>Pitar rudis</i>, <i>Spisula subtruncata</i>, <i>Acanthocardia paucicostata</i>, <i>Nephtys hombergii</i> and <i>Mytilus galloprovincialis</i></p>

Shallow circalittoral mixed sediment	CIRCA	MIXED	>9.7°C	>19m		Shallow circalittoral with <i>Dipolydora quadrilobata</i> meadows and <i>Mytilus</i>
Deep circalittoral muddy sand	DEEP CIRCA	MUDDY SAND	<9.7°C	>19m	<15.4kg/m ³	Deep circalittoral muddy sand with tunicates
Deep circalittoral mixed sediments	DEEP CIRCA	MIXED	<9.7°C	>19m	<15.4kg/m ³	Deep circalittoral shelly mud with <i>Modiolula phaseolina</i>
Deep circalittoral mud	DEEP CIRCA	MUD; SANDY MUD	<9.7°C	>19m	<15.4 kg/m ³	Deep circalittoral mud with <i>Terebellides stroemi</i> , <i>Amphiura stepanovi</i> , <i>Pachycerianthus solitarius</i>
Deep circalittoral suboxic calcareous muds	DEEP CIRCA	MUD	<9.7°C	>19m	>15.4 kg/m ³ <16.2 kg/m ³	Deep circalittoral suboxic muds with <i>Bougainvillia muscus</i>
Deep circalittoral anoxic muds	DEEP CIRCA	MUD	<9.7°C	>19m	>16.2 kg/m ³	Deep circalittoral anoxic muds
Bathyal anoxic muds	BATHYAL	MUD	The upper boundary is a break of slope manually defined			Bathyal anoxic muds
Abyssal seabed	ABYSSAL	ANY	The upper boundary is a break of slope manually defined			

12.2 Annex II: Updated crosswalk table for the Black Sea between MSFD benthic broad habitats and the full-detail habitat types used in EUSeaMap

Biozone	Inside river plume	Substrate	Oxygen regime	Broad-scale habitat 2018	MSFD Habitat
Infralittoral	no	Mud	Oxic	Infralittoral mud and sandy mud	Infralittoral mud
Infralittoral	no	Sand	Oxic	Infralittoral sand	Infralittoral sand
Infralittoral	no	Coarse sediment	Oxic	Infralittoral coarse and mixed Sediment	Infralittoral coarse sediment
Infralittoral	no	Mixed sediment	Oxic	Infralittoral coarse and mixed Sediment	Infralittoral mixed sediment
Infralittoral	no	Sandy Mud	Oxic	Infralittoral mud and sandy mud	Infralittoral mud
Infralittoral	no	Muddy Sand	Oxic	Infralittoral muddy sand	Infralittoral sand
Infralittoral	no	Rock	Oxic	Infralittoral rock	Infralittoral rock and biogenic reef
Soft bottom shallow circalittoral	no	Mud	Oxic	Shallow circalittoral mud	Circalittoral mud
Soft bottom shallow circalittoral	no	Sand	Oxic	Shallow circalittoral sand	Circalittoral sand
Soft bottom shallow circalittoral	no	Coarse sediment	Oxic	Shallow circalittoral shelly coarse sediment	Circalittoral coarse sediment
Soft bottom shallow circalittoral	no	Mixed sediment	Oxic	Shallow circalittoral mixed sediment	Circalittoral mixed sediment
Soft bottom shallow circalittoral	no	Sandy Mud	Oxic	Shallow circalittoral mud	Circalittoral mud
Soft bottom shallow circalittoral	no	Muddy Sand	Oxic	Shallow circalittoral mud	Circalittoral mud
Rocky circalittoral	no	Rock	Oxic	Circalittoral rock	Circalittoral rock and biogenic reef
Soft bottom deep circalittoral	no	Mud	Oxic	Deep circalittoral mud	Offshore circalittoral mud
Soft bottom deep circalittoral	no	Mud	Suboxic	Deep circalittoral suboxic calcareous muds	Offshore circalittoral mud
Soft bottom deep circalittoral	no	Mud	Anoxic	Deep circalittoral anoxic muds	Offshore circalittoral mud
Soft bottom deep circalittoral	no	Sand	Oxic	Deep circalittoral sand	Offshore circalittoral sand
Soft bottom deep circalittoral	no	Sand	Suboxic	Deep circalittoral suboxic sand	Offshore circalittoral sand
Soft bottom deep circalittoral	no	Sand	Anoxic	Deep circalittoral anoxic sand	Offshore circalittoral sand
Soft bottom deep circalittoral	no	Coarse sediment	Oxic	Deep circalittoral suboxic coarse sediment	Offshore circalittoral coarse sediment
Soft bottom deep circalittoral	no	Coarse sediment	Suboxic	Deep circalittoral coarse sediment	Offshore circalittoral coarse sediment



Soft bottom deep circalittoral	no	Coarse sediment	Anoxic	Deep circalittoral anoxic coarse sediment	Offshore circalittoral coarse sediment
Soft bottom deep circalittoral	no	Mixed sediment	Oxic	Deep circalittoral mixed sediment	Offshore circalittoral mixed sediment
Soft bottom deep circalittoral	no	Mixed sediment	Suboxic	Deep circalittoral suboxic mixed sediment	Offshore circalittoral mixed sediment
Soft bottom deep circalittoral	no	Mixed sediment	Anoxic	Deep circalittoral anoxic mixed sediment	Offshore circalittoral mixed sediment
Soft bottom deep circalittoral	no	Sandy Mud	Oxic	Deep circalittoral mud	Offshore circalittoral mud
Soft bottom deep circalittoral	no	Sandy Mud	Suboxic	Deep circalittoral suboxic sandy mud	Offshore circalittoral mud
Soft bottom deep circalittoral	no	Sandy Mud	Anoxic	Deep circalittoral anoxic sandy mud	Offshore circalittoral mud
Soft bottom deep circalittoral	no	Muddy Sand	Oxic	Deep circalittoral muddy sand	Offshore circalittoral sand
Soft bottom deep circalittoral	no	Muddy Sand	Suboxic	Deep circalittoral suboxic muddy sand	Offshore circalittoral sand
Soft bottom deep circalittoral	no	Muddy Sand	Anoxic	Deep circalittoral anoxic muddy sand	Offshore circalittoral sand
Bathyal	no	Mud	Anoxic	Bathyal anoxic muds	Upper bathyal sediment or Lower bathyal sediment
Bathyal	no	Sand	Anoxic	Bathyal sand	Upper bathyal sediment or Lower bathyal sediment
Bathyal	no	Coarse sediment	Anoxic	Bathyal coarse sediment	Upper bathyal sediment or Lower bathyal sediment
Bathyal	no	Mixed sediment	Anoxic	Bathyal mixed sediment	Upper bathyal sediment or Lower bathyal sediment
Bathyal	no	Sandy Mud	Anoxic	Bathyal sandy mud	Upper bathyal sediment or Lower bathyal sediment
Bathyal	no	Muddy Sand	Anoxic	Bathyal muddy sand	Upper bathyal sediment or Lower bathyal sediment
Abyssal	no	Mud	Anoxic	Abyssal seabed	Abyssal
Abyssal	no	Sand	Anoxic	Abyssal seabed	Abyssal
Abyssal	no	Mixed sediment	Anoxic	Abyssal seabed	Abyssal
Abyssal	no	Sandy Mud	Anoxic	Abyssal seabed	Abyssal
Infralittoral	yes	Sand	Oxic	Infralittoral sand	Infralittoral sand
Infralittoral	yes	Muddy Sand	Oxic	Infralittoral muddy sand	Infralittoral sand
Infralittoral	yes	Rock	Oxic	Infralittoral rock	Infralittoral rock and biogenic reef
Soft bottom shallow circalittoral	yes	Mud	Oxic	Circalittoral terrigenous muds	Circalittoral mud
Soft bottom shallow circalittoral	yes	Coarse sediment	Oxic	Circalittoral coarse and mixed sediment	Circalittoral coarse sediment
Soft bottom shallow circalittoral	yes	Mixed sediment	Oxic	Circalittoral coarse and mixed sediment	Circalittoral mixed sediment

Soft bottom shallow circalittoral	yes	Sandy Mud	Oxic	Circalittoral terrigenous muds	Circalittoral mud
Rocky circalittoral	yes	Rock	Oxic	Circalittoral rock	Circalittoral rock and biogenic reef

12.3 Annex III: Portal handover details

The following technical characteristics of the portal mean that transfer to another party is a relatively simple process:

1. The current portal uses a fully open-source infrastructure (Umbraco, Angular, PostgreSQL (with PostGIS), GeoServer and OpenLayers). These are well-established, mainstream open-source tools, with an active developer community providing a high level of support. GeoServer is cloud-hosted on Amazon Web Services and the transfer would be relatively simple to achieve by providing the configuration file and data to EASME or another party.
2. In addition to using open-source tools to create many of our EMODnet Seabed Habitat products (GRASS, R, Python), JNCC use open-source tools to prepare habitat maps for upload to the portal (Quantum GIS, Python, R), including the semi-automated tools developed for portal and data management. This will further ease the transition for another party to manage the portal, removing the need for proprietary GIS.
3. The metadata catalogue supporting the site is entirely hosted by the International Council for the Exploration of the Seas, so no transfer at all would be required to re-establish the metadata catalogue.
4. The portal is hosted off-site by Veber, using virtual machines on a Windows operating system. The staging servers also use virtual machines on a Windows operating system. Transfer could easily be achieved by cloud storage transfer, for example via Microsoft Azure.
5. The existing portal uses internationally-recognised interoperability standards for metadata and spatial data, which would facilitate a smooth transfer.

During the move to this open-source infrastructure as part of the previous project, JNCC ensured that the Intellectual Property Rights (IPR) on any code behind the portal was transferrable, and as necessary re-wrote code where Background IPR was owned by a third party. The resulting Foreground IPR is owned by JNCC and will be freely available under the UK Open Government Licence and transferrable as required.

We assume that any staff time to make the transfer would fall outside the scope of this contract. However, we guarantee our cooperation for transition meetings; staff would be made available to EASME as a priority for data and knowledge transfer, including staff from the website contractor.

12.4 Annex IV: List of pre-existing rights

The tables in the attached document list all the results or part of results of this project that have pre-existing intellectual property rights. Beyond this list, we declare that there are no pre-existing rights to any other results or parts of results of this project (i.e. they are openly available, usually under the Creative Commons licence).

The specific restriction for each of the datasets or data products listed below is that **they may not be made available to download, including by web feature service or web coverage service. They may only be made available to view on the interactive map, or by web mapping service.**

13 List of abbreviations and acronyms

API – Application Programming Interface

CCMAR – Centre of Marine Sciences

CMEMS – Copernicus Marine Environmental Monitoring Service

COCONET - Towards COast to COast NETworks of marine protected areas

DTM – Digital Terrain Model

EASME – Executive Agency for Small and Medium-sized Enterprises

EC – European Commission

EIA – Environmental Impact Assessment

EMFF – European Maritime and Fisheries Fund

EMODnet – European Marine Observation and Data Network

EOOS – Evolving the European Ocean Observing System

EOV – Essential Ocean Variable

ESH – EMODnet Seabed Habitat

ESRI – Environmental Systems Research Institute

EU – European Union

EUNIS – European Nature Information System

EurOBIS – European Ocean Biogeographic Information System

IFREMER – Institut français de recherche pour l'exploitation de la mer

INSPIRE – Infrastructure for Spatial Information in the European Community

IO-BAS – Institute of Oceanology, Bulgarian Academy of Sciences

GEUS – Geological survey of Denmark and Greenland

GIS – Geographic Information System

GOOS – Global Ocean Observing System

GRASS – Geographic Resources Analysis Support System

HCMR – Hellenic Centre for Marine Research

HD – Habitat Descriptor

HELCOM – Helsinki Commission (The Baltic Marine Environment Protection Commission)

ICES – International Council for the Exploration of the Sea

ICES WGMHM – ICES – Working Group on Marine Habitat Mapping

ICES WGFBIT – ICES – Working Group on Fisheries Benthic Impact and Trade-offs

ICG-COBAM – Intersessional Correspondence Group on the Co-ordination of Biodiversity Assessment and Monitoring

ICG-MPA – Intersessional Correspondence Group on Marine Protected Areas

ID – Identifier

IMDIS – International Conference on Marine Data and Information Systems
IMR – Institute of Marine Research
ISPRA – Italian institute for environment protection and research
JNCC – Joint Nature Conservation Committee
KdPAR – Attenuation Coefficient of the Photosynthetically Available Radiation at depth, d
MBA – Marine Biological Association
MediSeH – Mediterranean Sensitive Habitats
MERIS - Medium Resolution Imaging Spectrometer
MoU – Memorandum of Understanding
MPA – Marine Protected Area
MSFD – Marine Strategy Framework Directive
MSP – Marine Spatial Planning
NA – Not Applicable
NE – North East
NERC – Natural Environment Research Council
NIVA – Norsk institutt for vannforskning (Norwegian Institute for Water Research)
NGU – Geological Survey of Norway
OBIS – Ocean Biogeographic Information System
OGC – Open Geospatial Consortium
OSPAR – Oslo/Paris Convention (for the Protection of the Marine Environment of the North-East Atlantic)
PAR – Photosynthetically Available Radiation
PDF - Portable Document Format
QA – Quality Assurance
QC – Quality Control
RAC/SPA – Regional Advisory Centre for Specially Protected Areas
SSL – Secure Sockets Layer
SYKE – Finnish environmental institute
TWG – Technical Working Group
UK – United Kingdom
UKHO – United Kingdom Hydrographic Office
UNEP-WCMC – United Nations Environment Programme – World Conservation Monitoring Centre
VBA - Visual Basic for Applications
WFS – Web Feature Service
WMS – Web Mapping Service
WP – Work Package