GROWTH AND INNOVATION IN OCEAN ECONOMY

GAPS AND PRIORITIES IN SEA BASIN OBSERVATION AND DATA

D3.3.5 MedSea Checkpoint Challenge 2 (Marine Protected Areas): Description of Targeted Products, the methodology and the expert evaluation of fitness for purpose

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Author(s):	Sofia Reizopoulou	HCMR
	Chara Kyriakidou	HCMR
	Isidora Katara	HCMR
	Marianna Giannoulaki	HCMR
	Simona Simoncelli	INGV

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Glossary

MPA: Marine Protected Area
GIS: Geographical Information System
CoConet: Towards COast to COast NETworks of marine protected areas
IUCN: International Union for Conservation of Nature
IRIS: Integrated Regional monitoring Implementation Strategy in the South European Seas
SPAMI: Specially *Protected Areas* of Mediterranean Importance
FRA: Fisheries Restricted Area

Executive Summary

This report presents an overview of the Targeted Products of the WP3 Challenge 2 Marine Protected Areas. It describes the methodology used to develop the products and attempts to answer some of the primary questions regarding the adequacy and representativity of the Mediterranean Marine Protected Areas-Fisheries Restricted Areas network.
After some necessary inputs and modifications to the initial list, the final output contains six Targeted Products:

MEDSEA_CH2_Product_1
Title: Med protection initiatives (management and conservation areas)

MEDSEA_CH2_Product_2
Title: Med conservation areas, biological zones, fisheries restricted areas.

MEDSEA_CH2_Product_3
Title: Proposed regional conservation areas in the Mediterranean

MEDSEA_CH2_Product_4
Title: Qualitative analysis of connectivity between MPAs

MEDSEA_CH2_Product_5
Title: Representativity of habitats/species/other features, estuaries, lagoons etc.

MEDSEA_CH2_Product_6
Title: The monitoring capacity of biodiversity in MPAs

General scope of the Targeted Products

Networks of Marine Protected Areas (MPAs) are recognized worldwide as an important tool for biodiversity and ecosystem conservation, and are currently adopted by all EU marine and maritime policies. Mediterranean MPAs are threatened by external pressures at local, regional and global scales. Moreover, MPAs seem to function as separate entities, as they have not yet been established as parts of a functional network. More than half of the region's MPAs have not adopted a management plan, which means that these MPAs may only be considered as paper parks, significantly reducing the power of the region's conservation arsenal. Recently, a series of initiatives and regulations have motivated the shift from individual, autonomous MPAs to the concept of MPA networks.

Marine conservation throughout the Mediterranean is still constrained by crippling heterogeneities in the region's governance, institutional structures, wealth distribution, social capital and knowledge environment. It is clear that the management effectiveness of Mediterranean MPAs must be improved. Recent studies have focused on the ecological connectivity between MPAs; however, the information gained from these studies has not be integrated into and related to the measures to improve protection strategies.

According to Article 13 of the MSFD, spatial protection at the EU level should be addressed to provide a coherent and representative MPA network that adequately covers the diversity of species, habitats and ecosystems. The objective of this WP is to synthesize a large-scale analysis of environmental and socio-economic knowledge to assess the Mediterranean network of MPAs, and achieve a holistic approach to environmental protection. In the present report, we present our preliminary analysis of MPA Challenge 2 of the EMODnet MedSea Checkpoint, to assess the adequacy and representativity of the network in the Mediterranean Sea. The analysis was based on the Targeted Products and represents the first step towards overcoming data deficiencies such as the lack of information on specific management measures for each MPA, and of fine-scale, basin-wide distribution maps for priority habitats and vulnerable species. The analysis also allowed us to identify other data gaps and opportunities for improvement.

Targeted Products catalogue for this Challenge

The Targeted Products for challenge 2 are presented in Table 1.

Table 1. Targeted Products for Challenge 2

Name of Targeted Product	Short description	Format
MEDSEA_CH2_Product_1 Med protection initiatives (management and conservation areas)	Med protection initiatives (management and conservation areas). Collated data set (Excel file) containing information on MPA extension areas and their different protection levels.	.xls file
MEDSEA_CH2_Product_2 Med conservation areas, biological zones, fisheries	Shape file with the layers containing the information in MEDSEA_CH2_Product_1 and depth/biological zones. Fisheries Restricted Areas	.shp file

restricted areas.	with specific details on the prohibitions and type of closure.	
MEDSEA_CH2_Product_3 Proposed regional conservation areas	CoCoNET proposed MPAs, Greenpeace proposed MPAs.	.shp file
MEDSEA_CH2_Product_4 Qualitative analysis of connectivity between MPAs	Combination of seasonal MPA, temperature and current GIS layers	.shp and raster files
MEDSEA_CH2_Product_5 Representativity of habitats/species/other features	Combination of bathymetry, light, MPAs, Natura sites, seagrass distributions, coralligenous formations, Mediterranean Cetaceans, marine caves and transitional water bodies	.shp and raster files
MEDSEA_CH2_Product_6 The monitoring capacity of biodiversity in MPAs	Combination of MPAs and monitoring stations for biodiversity elements	.shp file

Description of characteristics and data sources used by Targeted Products

The following tables present the names of the characteristics (according to P02 nomenclature), the environmental matrix and the relevant data source for each Targeted Product. The production of these tables was based on the Sextant Metadatabase information.

MEDSEA_CH2_Product_1

Nb	Characteristics name (P02)	Environmental Matrix	Data source (URL)
1	Marine Protected Areas*	Marine Water	CoConet http://www.coconet-fp7.eu/

*P02 code: ADUN

MEDSEA_CH2_Product_2

Nb	Characteristics name (P02)	Environmental Matrix	Data source (URL)
1	Marine Protected Areas*	Marine Water	CoConet http://www.coconet-fp7.eu/
2	Biological Zones/Depth zones**	Seabed	http://www.emodnet.eu/seabed-habitats
3	Fisheries Restricted Areas (FRAs)	Marine Water	Marea and Mediseh http://mareaproject.net/

*P02 code: ADUN
**P02 code: LITH

MEDSEA_CH2_Product_3

Nb	Characteristics name (P02)	Environmental Matrix	Data source (URL)
1	CoCoNET proposed MPAs*	Marine Water	CoConet http://www.coconet-fp7.eu/
2	Greenpeace	Marine Water	http://www.greenpeace.org/seasia/ph/What-

	proposed MPAs*		we-do/oceans/marine-reserves/the-mediterranean/a-network-of-marine-reserves/

*P02 code: ADUN

MEDSEA_CH2_Product_4

Nb	Characteristics name (P02)	Environmental Matrix	Data source (URL)
1	Marine Protected Areas*	Marine Water	CoConet http://www.coconet-fp7.eu/
2	Temperature of the water column**	Marine Water	http://www.copernicus.eu/
3	Horizontal velocity of the water column (E and N components)***	Marine Water	http://www.copernicus.eu/

*P02 code: ADUN
**P02 code: TEMP
***P02 code: RFVL

MEDSEA_CH2_Product_5

Nb	Characteristics name (P02)	Environmental Matrix	Data source (URL)
1	Marine Protected Areas*	Marine Water	CoConet http://www.coconet-fp7.eu/
2	Bathymetry**	Fresh Waters	http://www.emodnet-hydrography.eu/
3	Seabed light	Seabed	http://www.emodnet.eu/seabed-habitats
4	Fract. light (fraction of surface light reaching the seabed)	Seabed	http://www.emodnet.eu/seabed-habitats
5	Natura2000*	Marine Water	http://natura2000.eea.europa.eu/
6	Transitional water bodies	Marine Water	http://www.eea.europa.eu/data-and-maps/data/waterbase-transitional-coastal-and-marine-waters-8
7	Habitats substrate****	Seabed	http://www.emodnet.eu/seabed-habitats
8	Marine caves*****	Biota	Giakoumi, et. Al, 2013 (Plos One)
9	Posidonia oceanica*****	Biota	Giakoumi, et. Al, 2013 (Plos One) Telesca et al, 2015
10	Coralligenous formations*****	Biota	Giakoumi, et. Al, 2013 (Plos One); Martin et al, 2014 (Nature)
11	Mediterranean Cetaceans**	Biota	IUCN (http://www.iucnredlist.org/)

*P02 code: ADUN
**P02 code: MBAN
****P02 code: LITH
*****P02 code: HBEX

MEDSEA_CH2_Product_6

Nb	Characteristics name (P02)	Environmental	Data source (URL)

		Matrix	
1	Marine Protected Areas*	Marine Water	CoConet http://www.coconet-fp7.eu/
2	Biodiversity monitoring stations	Biota	IRIS http://iris-ses.eu/

*P02 code: ADUN

Description of the method used to produce the Targeted Products

A large inventory of Mediterranean MPAs was built as a baseline for the assessment of the Mediterranean MPA network. The inventory was based on the available scientific information from different sources such as online databases, articles and project reports. All available information was catalogued in an Excel file. The collected datasets were then processed and organised in geodatabases. The final products are GIS maps related to:

1. the existing and proposed MPAs, and
2. the conservation features that the MPA network aims to protect.

Maps of the available scientific information were created using ArcGIS and disseminated through the project's portal at http://www.emodnet-mediterranean.eu/portfolio/marine-protected-areas/.
The collected information was used to assess the coherence, adequacy and representativity of the MPA network in the Mediterranean as listed in Art 13(4) of the MSFD. The analysis involved the use of GIS procedures and modules to combine the information layers and to derive adequacy and representativity indexes.

The Targeted Products were produced by the following method.

- After the initial selection of the necessary characteristics for generating each Targeted Product, we reconsidered all of the available databases and downloaded the data sets associated with these characteristics. Many of the data sets used for the creation of the products were not freely available, so we had to consider the data policy related to the individual data providers.
- All of the data sets were pre-processed to ensure they were in the appropriate format for conversion into GIS layers.
- The data on sea surface temperature and currents belong to the Mediterranean Sea Physical Reanalysis produced by INGV (Simoncelli et al., 2016) and are freely distributed by the Copernicus Marine Environment Monitoring Service. The daily and monthly model data, covering the 1987-2014 period and downloaded from the CMEMS online catalogue in netcdf files, were used to produce seasonal climatologies and then post-processed into shape and raster files appropriate for GIS. The seasonal climatologies of sea surface temperature and currents provide qualitative information on the oceanographic features that are most likely to affect the connectivity of MPAs due to the passive transport of larvae.
- Each layer corresponds to one data set and contains all of the related information. For instance, for the Marine Protected Areas, an attribute table such as that in Table 2 was prepared.

- An individual project was created for each product using the GIS platform (mxd file). This procedure offers the possibility of combining all of the information layers.
- GIS modules were used to calculate indicators relating to the proportion of the areas that are already protected versus the total area that needs to be protected. The indicators refer mainly to areas occupied by priority habitats or species. Other indicators were also calculated, such as the size and distribution of the MPAs.

Table 2. Attributes of Marine Protected Areas

PROTECTED *information*	SITE NAME *information*	ORIGIN NAME *information*	COUNTRY *information*	RESPONSIBLE *information*	ZONING *information*	NOTAKEREGU *information*	SITE TYPE *information*	MARINE AREA *information*	MARINE AREA1 *information*
TOTAL AREA *information*	LINKINFO *information*	METADATA *information*	BEGINLIFES *information*	ENDLIFESPA *information*	SITE DESIGN *information*	SITE DESIG1 *information*	ORIGIN SITE *information*		
SITEDESIG2 *information*	shape_area *information*	shape_length *information*							

Figure 1A reports the method used to produce the Targeted Products for this challenge.

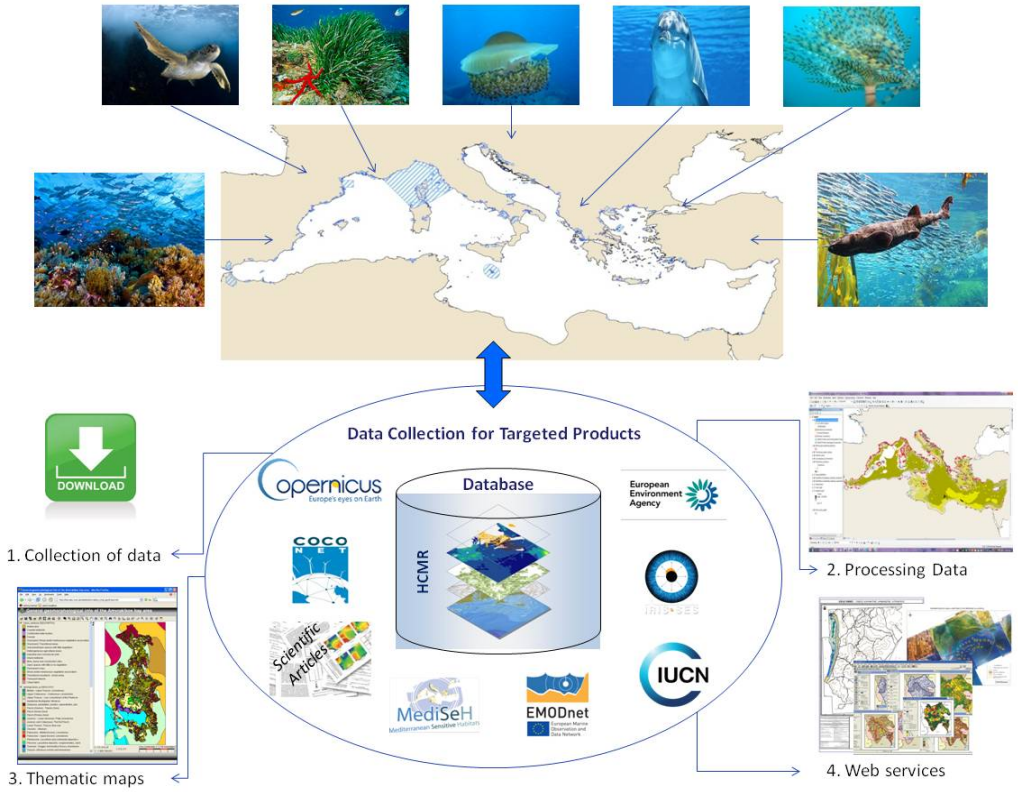

Figure 1. The production of challenge 2 Targeted Products.

Analysis of results

A**dequacy** and **representativity** are key characteristics of MPA networks. **Adequacy** is defined as a network's ability to ensure the long-term protection of biodiversity and ecological viability, and is related to the network and reserve size, configuration and level of protection. According to the Azores Scientific Guidance, **representativity** is "captured in a network when it consists of areas

representing the different biogeographical subdivisions of the global oceans and regional seas that reasonably reflect the full range of ecosystems, including the biotic and habitat diversity of these ecosystems" (Brock, 2015).

The Mediterranean MPA-FRA network was assessed against these two concepts, based on the Targeted Products of this challenge. Figure 2 shows the rationale we followed to derive the indicators of adequacy and representativity for the existing MPA-FRA network, using the previous geodatabase information layers as input for the analysis. The data manipulation and analyses were performed in ArcGIS (ESRI) and R (R project).

Monitoring and assessment of MPAs is an integral part of their development. The development of MPA networks is an ongoing and iterative process, in which the efficiency of the network is achieved through meticulous planning, persistent monitoring and scrutiny and constant improvements. FRAs are an additional form of protection that cannot be ignored in the evaluation of protection networks. An FRA is an area in which a certain fishery is closed or restricted by a government entity or regional authority. An FRA can be closed to fishing permanently, temporarily or seasonally, and this closure may apply to one or more type of gear. Fisheries restrictions are often implemented in MPAs as a conservation measure.

However, assessments are often limited by data deficiencies, including a lack of conservation policies such as nationally established FRAs and a lack of information on the ecology of vulnerable ecosystems. The data produced in this WP allowed us to overcome limitations such as the lack of distribution maps for priority species and habitats, and the absence of publicly available management plans for the majority of Mediterranean MPAs.

FRAs derived from the MEDISEH project (Giannoulaki et al., 2013; Papadopoulou et al., 2012) were considered for this analysis. Both spatial and seasonal restrictions were considered. Data on the distribution (presence probability) of vulnerable habitats, i.e., Posidonia beds, coralligenous and maërl substrate were derived from the MEDISEH project (Giannoulaki et al. 2013; Belluscio et al. 2013). Details on the datasets can be found in Telesca et al. (2015) and Martin et al. (2014). Both data sources on the data distribution of protection initiatives and the distribution of priority habitats/species are crucial for an in-depth assessment of the current MPA-FRA network, which will allow us to identify specific gaps in conservation efforts.

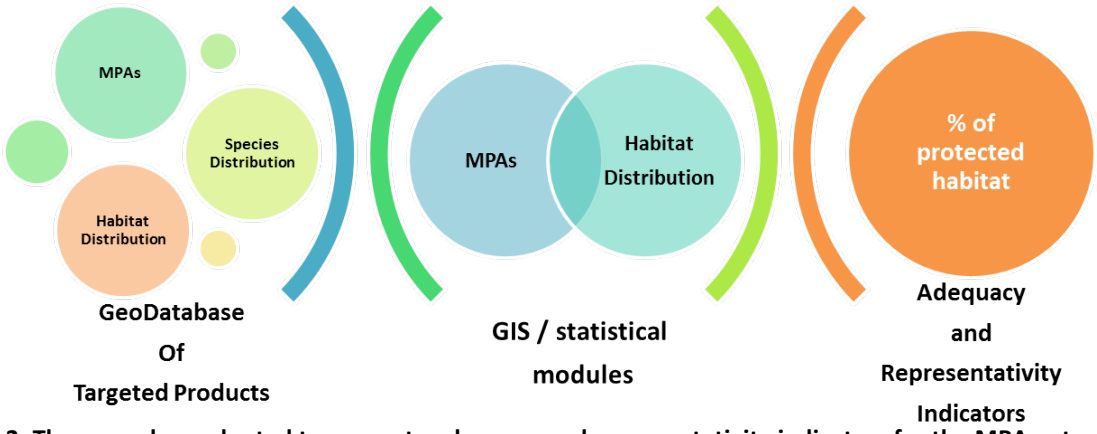

Figure 2: The procedure adopted to generate adequacy and representativity indicators for the MPA network based on the challenge 2 geo-database of information layers.

We assessed the proportion of the Mediterranean Sea area currently under a protection initiative and the size of the protected areas. The values presented in Tables 3 and 4 refer to the following groups of protection initiatives:

i. all protection initiatives characterized as MPAs and Natura 2000 sites,
ii. SPAMIs only,
iii. Natura 2000 sites only, and
iv. FRAs – where fishing gear is prohibited all year round.

Tables 3 and 4 summarize the results on adequacy. The percentage of protected areas is generally low (< 10%), as is the median size of the protected areas (5 km^2, where 20 km^2 is considered an optimal size). Only the SPAMI-related sizes are larger, but the numbers are biased by one large SPAMI, the Pelagos sanctuary.

Protection Initiatives	Number of areas	Area Size [km^2] (without Pelagos)	% of the Med Sea (without Pelagos)
All MPAs	781	239624.3 (135045.9)	6% (3.4%)
Natura 2000	502	63473.8	1.6%
SPAMIs	38	163763.4 (5057.3)	4% (0.1%)
FRAs all gear types		5866	0.15%
FRAs bottom trawling		162.6	0.004%
FRAs purse seiners		43536.2	1%
FRAs small scale gear		2388539	59%

Table 3. Percentage of the Mediterranean Sea that is adequately protected. Areas are in km^2 and refer only to the marine part of the protected areas.

Protection Initiatives	% of areas>20 km^2	Median Size [km^2]	Median Size* [km^2]
All MPAs	40	5	21
Natura2000 sites	33	2.4	16.4
SPAMI	77	92	27

Table 4. Percentage of areas more than 20 km^2, which is considered an adequate size for an MPA. Area size refers either to the marine part of Protection Initiatives (PIs) or (*) to strictly marine PIs.

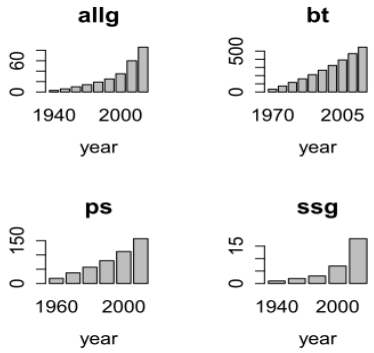

Figure 3. The evolution of the area covered (shown as cumulative sum) by the established Fisheries Restricted Areas. ps: purse seines, bt: bottom trawls, allg: all gear, ssg: small scale gear.

Representativity was assessed for a number of priority habitats and species including Posidonia beds, coralligenous substrate, cetaceans, etc. **Annex 2** includes detailed maps and tables that assess the representativity of five examples of priority species and habitats, namely Posidonia beds, coralligenous formations, cetaceans, lagoons and biozones.

Expert evaluation of Targeted Product quality and gaps in the input data sets

The objective is to provide an expert evaluation of the "fitness for purpose and use" for each Targeted Product. The coordinator asked the challenge teams to provide the following information.

1. Assign an overall product quality score with respect to scope (fitness for purpose) and explain why, according to the scale in **Table A**.
2. Identify the most important characteristic(s) for the Targeted Product quality (if all characteristics are important, please say so).
3. Identify which quality element(s) (see Annex 1) of the most important characteristic(s) affects the Targeted Product quality.
4. Identify the limitations of the quality of the Targeted products due to the input data set used.
5. Explain which of the characteristics "most fails" to meet the scope of the Targeted Product.
6. Provide an expert judgement of the most important **gaps in the input data sets** for each Targeted Product.

SCORE	MEANING
1	EXCELLENT → completely meets the scope of the Targeted Product
2	VERY GOOD → meets more than 70% of the scope of the Targeted Product
3	GOOD → meets less than 50% of the scope of the Targeted Product
4	SUFFICIENT → does not adequately meet the scope but is a starting point
5	INADEQUATE → does not fulfill the scope and is not usable

Table A Targeted Products quality scores and their meaning.

MEDSEA_CH2_Product_1

1. The product's quality score is **very good** (2). However, both the North African MPAs and the management measures for each MPA need to be updated and quality controlled. At the time of the analysis, specific information on the management plans was not available for some of the MPAs, especially those located in the south of the Mediterranean. There was also little information on enforcement. Detailed information on management measures and levels of enforcement are critical for a species- or habitat-level evaluation of an MPA network. MPAs that do not protect the specific species or habitat, or MPAs with low enforcement levels, should be weighted down in an assessment of the Mediterranean MPA network. Scientific output for MPAs in the southern part of the Mediterranean is often not communicated and hence is unavailable.
2. The product considers a unique characteristic. The most important details for this product include the name of the protected area, date (year) of designation, type of designation and legal status (e.g. under EU legislation, international convention, or national mechanism), location of the protected area (coordinates; GIS polygon), size of the designated area (marine component) (km^2), biodiversity protected features (type of marine features being protected, i.e. habitats, species, ecosystems) and management measures in place (IUCN categories, management plans).

3. The spatial extent, accuracy and relevance of the information on the product are important quality elements. Two inputs, namely biodiversity protected features (type of marine features being protected, i.e. habitats, species, ecosystems) and management measures in place (IUCN categories, management plans), have missing information, which decreases the overall quality of the product. A small percentage of the MPAs do not have complete information regarding designation and management.
4. There are no limitations on the use of this product. The information used is accurate and based on reliable databases (EEA; MedPan and the EU CoCoNet project). The list of MPAs for the northern Mediterranean is comprehensive and the spatial resolution is adequate.
5. The conservation features and management measures of European MPA databases need to be updated, and management plans are often missing. The most detailed information for the Mediterranean MPAs is available for SPAMIs (Specially Protected Areas of Mediterranean Importance).
6. As mentioned above, information on enforcement levels is lacking and difficult to obtain. Collecting information on the implementation of management plans is challenging, but could prove crucial for an in-depth evaluation of the Mediterranean MPA network. More detailed information on the protected features (habitats, species, and ecosystems) and management measures in place are required to improve the product's quality.

MEDSEA_CH2_Product_2

1. The overall score is **excellent** (1), given that all product components are fit for purpose.* Biological zones are based on high quality input data and models (http://www.emodnet-seabedhabitats.eu/pdf/seabed_habitats_final_report_v3.pdf), and constitute a valuable habitat descriptor for biological and conservation studies. FRAs are an important layer of information for the assessment of protection initiatives. Both components are detailed enough to allow a thorough evaluation of the effectiveness of FRAs, accounting for the different impacts of fishing gears on different biological zones and/or depths.
2. The two most important characteristics for this product are the biological zones and FRA distribution layers. The main information for FRAs is the date (year) of designation, types of prohibited gear, legal information, location of FRAs (coordinates; GIS polygon), type of closure (temporal and spatial) and duration of temporal closures.
3. Spatial resolution has the greatest effect on the quality of this product. The resolution is high for this data set (cell size is 250 meters). Both characteristics of the product are complete and relevant. Model improvements regarding the biological zones and regular updates of the FRAs dataset would further increase the quality of the product.
4. The information used is accurate and based on reliable databases (EMODnet Bathymetry, EMODnet Seabed Habitats, Mediseh FRAs), thus at present, there are no limitations on its use. The FRA component of the product should be updated to reflect changes in fisheries policies.
5. Both upstream characteristics are essential for the designation and assessment of MPAs. Bathymetry is indicative of habitats and is a significant parameter for habitat and species distribution models. Seabed habitats are often indicative of marine communities and ecological processes. In contrast to European databases on MPAs, the FRAs database

*Component 1 (FRAs, Fisheries Restricted Areas) and component 2 (biological zones, depth zones).

includes detailed information on the conservation features and management measures enforced.
6. No specific gaps are identified.

MEDSEA_CH2_Product_3

1. The overall score is **good** (3). The two characteristics summarize all of the information on proposed MPAs to date, at the scale of the entire Mediterranean basin. The product is useful for assessing the adequacy and appropriateness of the proposed network of protected areas, especially in relation to environmental change.
2. The most important characteristic is the conservation areas for the Mediterranean proposed by Green Peace and captured by the CoCoNet project.
3. The product information is useful for assessing the level of protection for Mediterranean conservation features under different strategic goals and considering the agendas of stakeholders. The product is accurate but possibly incomplete. The spatial extent covers the entire Mediterranean basin. The spatial extent and completeness of the dataset are important quality elements.
4. The main data source, CoCoNet, is considered accurate and reliable, thus there are no limitations on the use of this product. Caution is needed when the product becomes out-of-date; regular updates are needed to capture new proposals for MPAs in the Mediterranean.
5. The characteristic that "fails the most" to meet the scope of the Targeted Product is the MPAs proposed by Greenpeace, as scientific information on these layers is not available.
6. There is a need for a thorough review of all initiatives relating to the designation of MPAs, regardless of whether they are successful. More detailed information on the proposed management plans for the proposed locations is needed to achieve insight into the driving forces behind the proposed MPAs.

MEDSEA_CH2_Product_4

1. The product is considered **sufficient** (4) because it only provides a qualitative indication of the connectivity between the Mediterranean MPA networks. Seasonal climatological currents and temperature fields represent the averages for the 1987-2014 period, thus they can be considered as probable larvae tracks if considered as passive tracers. However, for some species, where larval dispersion is driven by small-scale, transient oceanographic features, this resolution is not adequate.
2. The most important characteristics are the currents and temperature in the surface layer. However, to estimate the connectivity at the basin scale, further **information on larval biology** is needed to parameterize the relevant biophysical models (not used here).
3. The information is a first attempt to evaluate the connectivity of MPAs in the Mediterranean Sea. The temporal resolution (seasonal maps) of the product is insufficient to provide quantitative information on the connectivity. Further analysis using biophysical modelling for larval dispersal simulations and Copernicus input datasets is needed (see *Andrello et al. 2013, Rossi et al. 2014*, *Berline et al. 2014*), but would require much greater effort than that allocated by the current project. Biophysical models can provide connectivity estimates over potentially large spatial scales, such as entire sea basins or

oceans (*Lagabrielle et al. 2014*), and can be used to derive estimates of connectivity over years or generations, and even projections for the future. Although the literature documents many limitations to this methodology, it is the only one that considers the whole basin scale. Biophysical models provide estimates of **potential connectivity**, because they cannot take into account post-settlement processes (mortality and juvenile movements**)**, while other methods provide estimates of realized connectivity. Moreover, biophysical models can only provide unbiased estimates of connectivity if sufficient **knowledge of larval biology** is available to parameterize the models, and if there is a sufficiently precise hydrodynamic model for the study region. In our case, we can say that the Copernicus MED-MFC model is adequate for this purpose. Nevertheless, even if all of the processes known to affect connectivity measurements in biophysical models can in theory be modelled and integrated, **the real limitation to producing accurate model-based connectivity assessments is the scarcity of knowledge and data about larval biology for most species, especially in natural (non-laboratory) conditions** (*Lagabrielle et al. 2014*).

4. The main limitation on the quality of the product and its usability is related to the qualitative assessment of connectivity rather than the input dataset used. Again, t**he real limitation to producing accurate model-based connectivity assessments is the scarcity of knowledge and data about larval biology for most species, especially in natural (non-laboratory) conditions. No input data set has been identified within the project at the present time.**
5. None of the characteristics and respective data sets fails to meet the scope of the Targeted Product (fitness for use). However, high-quality, high-frequency and long time series ocean current data are necessary to develop statistical maps of connectivity, while a database of the main species populating the Mediterranean MPAs and their principal larval biological information (spawning time, larval lifetime, larval behaviour, favourable larval conditions) is crucial.

MEDSEA_CH2_Product_5

1. Overall, the product's quality is considered to be **good** (3). The information available is insufficiently detailed to allow a full assessment of the adequacy of the MPA network in terms of marine biodiversity hotspots and priority species or habitats. Given that conservation of marine biodiversity is a primary goal of MPA networks, the product is considered to be incomplete. However, the information on some of the characteristics is adequate to assess the representativity and replication of the MPA network in the Mediterranean.
2. All characteristics are an important element of marine biodiversity and are crucial for MPA network assessment purposes. All characteristics related to this product provide good baseline information for conducting a representativity analysis in the Mediterranean Sea. However, there is room for improvement in each characteristic, with the level of improvement needed varying between datasets.
3. The datasets are spatially accurate, complete, and, in the case of transitional waters, thematically accurate (coastal lagoons are a priority habitat for Natura 2000 sites). The spatial extent is adequate, covering the entire Mediterranean. The bathymetry layer can be improved for coastal areas (resolution and accuracy), especially because most MPAs are

coastal. The Mediterranean cetaceans layer affects the Targeted Product quality due to its low spatial resolution and accuracy.

4. The information used is accurate and based on reliable databases. However, the limited information on **marine biodiversity characteristics** lowers the usability of the data. More specific information on the abundance of priority species would lead to more accurate estimates of representativity. The input data for this product only indicate presence/absence, with a low spatial resolution.
5. The characteristic that "fails the most" to meet the scope of the Targeted Product is the Mediterranean cetacean distribution. There is a discrepancy between the distribution of Mediterranean cetaceans and the distribution of the MPA and FRA networks, the resolution of the first being very low. More detailed information on the abundance of this and other cetacean species is required for the assessment of representativity.
6. The scientific information needs to be updated and completed. The main gaps were related to the **availability of biodiversity data,** especially on protected species. Maps of the abundance of protected species are necessary to assess the current network and designate additional protected areas. The habitats directive specifically requires abundance estimates and maps for cetaceans and sea birds for MPA designation purposes. More information on this has recently become available, and these new data will be further elaborated and included in the database.

MEDSEA_CH2_Product_6

1. The overall product score is **sufficient** (4). The product aims to assess the capacity of the current biodiversity monitoring networks as they overlap with MPAs. The information is limited to coastal areas, and it is difficult to obtain information on internal monitoring from MPA managers.
2. The most important characteristic for the product's quality is the biodiversity monitoring network, which includes the operational monitoring network of EU directives (mostly WFD) on eutrophication, zooplankton water column habitats, phytoplankton water column habitats, zoobenthos seabed habitats, phytobenthos seabed habitats and non-indigenous species in coastal sites.
3. The quality element that affects the quality of this product the most is the data completeness, because information on the southern Mediterranean is missing. However, the information provided is very useful to evaluate the efficiency of biodiversity monitoring in MPAs. The biodiversity monitoring stations do not meet the quality principles for thematic accuracy and completeness because (i) the stations are restricted to monitoring networks in coastal areas and (ii) only metadata, not biodiversity data, are available.
4. The development of the product was based on accurate data collection and analysis from the IRIS-SES project, but the spatial extent and completeness of the data are inadequate.
5. The IRIS-SES database did not fail to meet the scope of this product, but the usability of the product would be greatly improved by the availability of data on the monitored parameters covering the whole Mediterranean basin. At the moment, only the monitoring scheme can be assessed.
6. Most of the characteristics related to marine biodiversity are considered insufficient due to the limited availability of scientific information (only the positions of the monitoring stations are given) and the insufficient information on monitoring in deep waters.

TP	CH2
1	2
2	1
3	3
4	4
5	3
6	4

Table B Summary of the quality scores associated with each Targeted Product according to the experts' evaluations and the evaluation the scheme presented in Table A.

Annex 1: Definitions

We extracted the following definitions from the MedSea Literature Survey:

Characteristic

In this document, a "characteristic" is a distinguishing feature that refers

1. either to a variable derived from the observation, the measurement, or the numerical model output of a phenomenon or of an object property in the environment; or
2. to the geographical representation of an object on a map (i.e., a layer such as a protected area, a coastline or wreck) by a set of vectors (polygon, curve, point) or a raster (a spatial data model that defines space as an array of equally sized cells such as a grid or an image).

Environmental matrices

This concept is introduced to avoid ambiguities when using a characteristic name such as "temperature". The environment matrix is the environment to which a characteristic is related, which we define as

1. Air
2. Marine Water
3. Fresh Water
4. Biota/Biology
5. Seabed
6. Human activities.

Quality principles

- ✓ ***Spatial extent***
  Box or geographic region bounding the datasets.
- ✓ ***Spatial resolution***
  Size of the smallest object that can be resolved on the ground. In a raster dataset, the resolution is limited by the cell size.
- ✓ ***Spatial accuracy***
  Requested closeness of coordinate values to values accepted as or being true e.g. on the base of the instrument used.
- ✓ ***Time extent***
  Time interval represented by the dataset or by the collection.
- ✓ ***Time resolution***
  Size of the smallest interval of time that can be resolved.
- ✓ ***Time accuracy***
  Requested closeness of temporal values to the values that are accepted as or are true.
- ✓ ***Usability***
  The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use.
- ✓ ***Completeness***
  Amount of missing data in a dataset.
- ✓ ***Logical consistency***
  Degree of adherence to the required format.
- ✓ ***Thematic accuracy***
  Requested closeness of characteristic values to the values that are accepted as or are true (the so-called attribute of a data entity, e.g., "wave height"). It includes the correctness of the classification of features or their associations.

Annex 2: Mediterranean MPAs Representativity

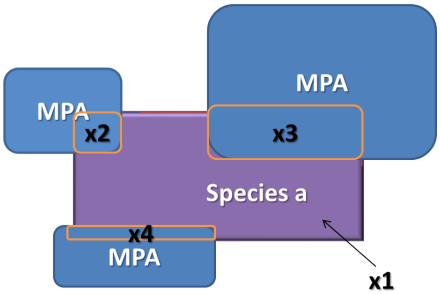

Figure A1: Generic scheme describing the representativity calculation: *Representativity=(x2+x3+x4)/x1*, where *x1* is the total distribution area for *species a*, and *x2*, *x3*, *x4* are areas where *species a* overlaps with an MPA. When additional information, such as the probability of presence, is available, the fraction is weighted.

Posidonia

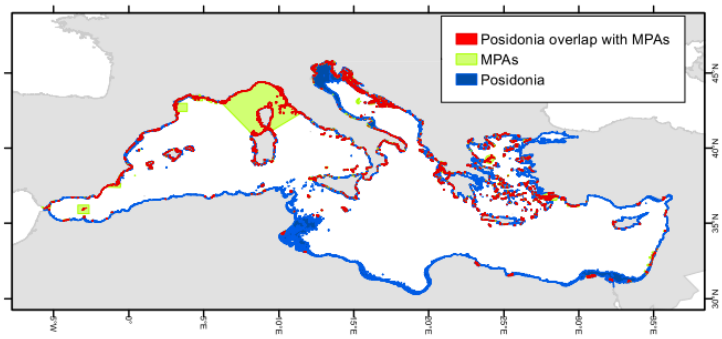

Figure A2: Map of the overlap (red) between MPAs and Posidonia beds.

Table A1: Summary of the representativity results for Posidonia beds. The first column shows the protection initiative (i.e. the component of the MPA-FRA network) against which representativity was assessed. The second column (overlap) shows the area of overlap between the protection initiative and the Posidonia beds in km^2. The third column gives the percentage of Posidonia beds that is protected.

protection	overlap	%
MPAs	9.18E+009	17.308426
MPAs (without Pelagos)	8.98E+009	16.930872
SPAMI	2.74E+009	5.1653412
SPAMI (without Pelagos)	733224649	1.3831298
Natura 2000	6.82E+009	12.86097
FRAs all gear	459595567	0.8669653
FRAs Bottom trawls	3.30E+010	62.177307
FRAs dynamic small scale gear (depth < 1000)	2.39E+009	4.5031144
FRAs passive small scale gear (depth < 1000)	196660232	0.3709731

Coralligenous

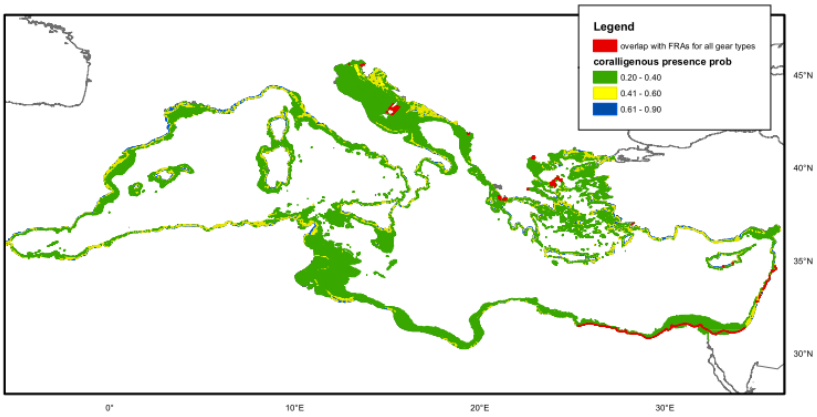

Figure A3: Map of the overlap (red) between FRAs for all fishing gear types and areas characterised as coralligenous substrate. The probability of presence of coralligenous substrates is also given.

Table A2: Summary of the representativity results for coralligenous substrates. The first column shows the protection initiative (i.e., the component of the MPA-FRA network) against which representativity was assessed. The second column (overlap area) shows the area of overlap between the protection initiative and the coralligenous substrates in km^2. The third column gives the percentage of the coralligenous substrates area that is protected.

protection	Overlap area	%
MPAs	28816783728.7	0.1309681
MPAs (without Pelagos)	27553761572.1	0.1252279
SPAMI	12419238451.3	0.0564437
SPAMI (without Pelagos)	1511242098.67	0.0068684
Natura 2000	14804733981.3	0.0672854
FRAs all gear	956847463.789	0.0043487
FRAs Bottom Trawl	0	0
FRAs small scale gear	15132782682	0.0687763
FRAs dynamic small scale gear (depth < 1000)	14777125759.8	0.0671599
FRAs passive small scale gear (depth < 1000)	343176705.081	0.0015597

Transitional Water Bodies

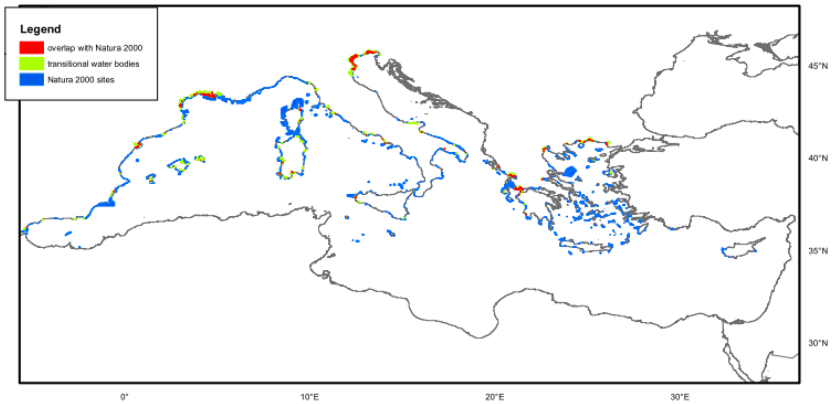

Figure A4: Map of the overlap (red) between Natura 2000 sites and areas characterised as transitional water bodies.

Table A3: Summary of the representativity results for transitional water bodies. The first column shows the protection initiative (i.e. the component of the MPA-FRA network) against which representativity was assessed. The second column (area) shows the area overlap the protection initiative and the transitional water bodies in km^2. The third column gives the percentage of the transitional water bodies' area that is protected.

protection	area	%
MPAs	1.20E+009	0.2002664
MPAs (without Pelagos)	1.20E+009	0.2002659
SPAMI	1958452	0.0003262
SPAMI (without Pelagos)	1031618	0.0001718
Natura 2000	1.19E+009	0.1979278
FRAs all gear	94305029	0.0157061
FRAs Bottom Trawl	914276491	0.1522686
FRAs Pelagic Trawl	567380933	0.0944947
FRAs Purse Seines	375376120	0.0625172
FRAs small scale gear	1.28E+010	2.1395831

Cetaceans

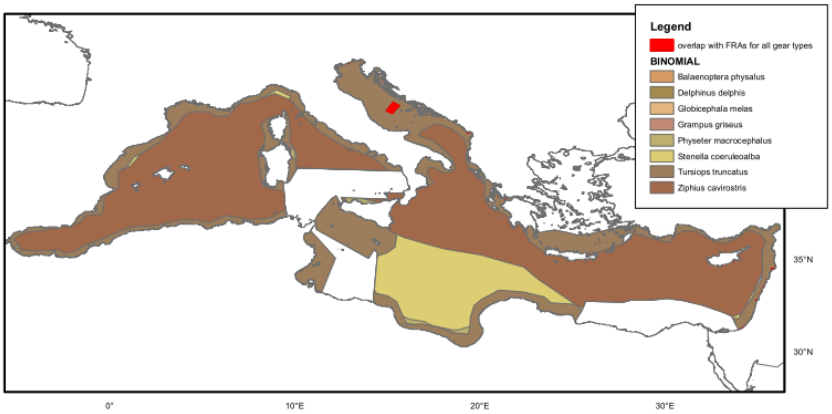

Figure A5: Map of the overlap (red) between FRAs for all fishing gear types and the distribution of cetaceans, derived from IUCN.

Table A4: Summary of the representativity results for Delphinus delphis. The second column shows the protection initiative (Pis, i.e., the components of the MPA-FRA network) against which representativity was assessed. The second column shows the percentage of the species distribution area that is protected.

species	protection	%
Delphinus delphis	all Pis	2.0177177
Delphinus delphis	all Pis without Pelagos	1.418746
Delphinus delphis	FRAs all gear	0.0143034
Delphinus delphis	FRAs bottom trawl	72.284548
Delphinus delphis	FRAs dynamic small scale gear (depth < 1000)	0.6401752
Delphinus delphis	FRAS dynamic small scale gear (depth > 1000)	69.632635
Delphinus delphis	FRAs passive small scale gear (depth < 1000)	0.0074451
Delphinus delphis	FRAs passive small scale gear (depth > 1000)	1.00E-005
Delphinus delphis	FRAs pelagic trawls	12.097083
Delphinus delphis	FRAs Purse seines	0.5243324
Delphinus delphis	Natura 2000	0.6762081
Delphinus delphis	SPAMI	0.9012673
Delphinus delphis	SPAMI without Pelagos	0.1124027

Biozones

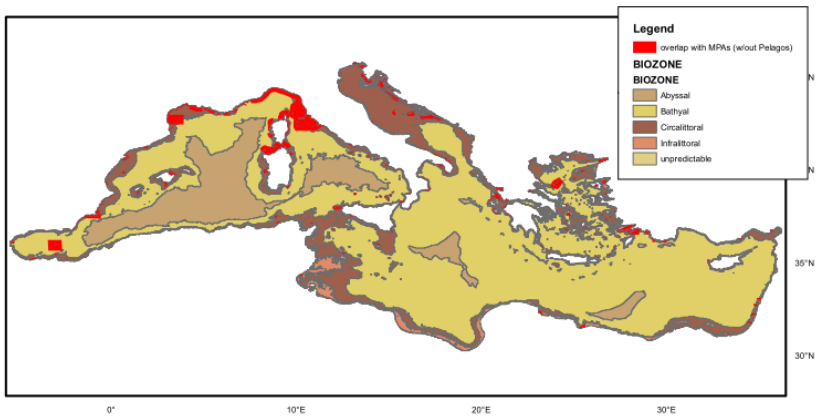

Figure A6: Map of the overlap (red) between MPAs (Pelagos excluded) and different biozones.

Table A5: Summary of the representativity results for each biozone. The second column shows the protection initiative (i.e. the component of the MPA-FRA network) against which representativity was assessed. The second column shows the percentage of the biozone area that is protected.

biozone	protection	%
Abyssal	MPAs	3.6161884
Bathyal	MPAs	3.8965652
Circalittoral	MPAs	8.4582467
Infralittoral	MPAs	14.313683
Bathyal	MPAs without Pelagos	1.3407723
Circalittoral	MPAs without Pelagos	7.9385823
Infralittoral	MPAs without Pelagos	14.193559
Bathyal	Natura 2000	0.3872094
Circalittoral	Natura 2000	3.394593
Infralittoral	Natura 2000	9.9249988
Abyssal	SPAMI	3.6161884
Bathyal	SPAMI	3.2487195
Circalittoral	SPAMI	4.4602254
Infralittoral	SPAMI	3.8154428
Bathyal	SPAMI no Pelagos	0.0104434
Circalittoral	SPAMI no Pelagos	0.4024653
Infralittoral	SPAMI no Pelagos	0.9156504

Engraulis encrasicolus breeding/spawning grounds

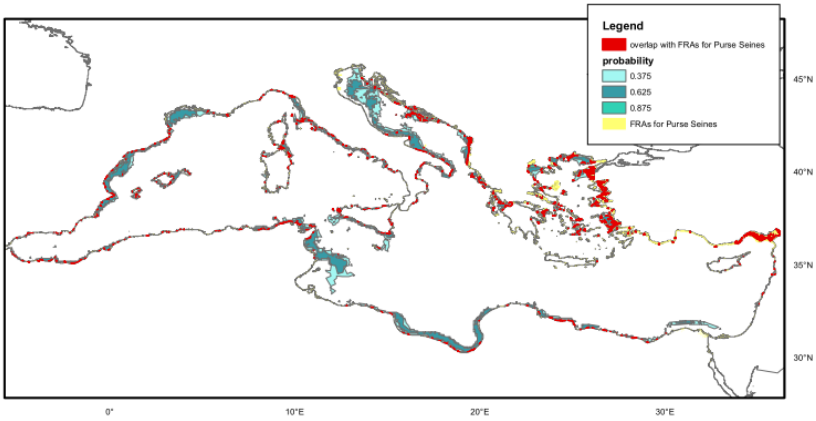

Figure A7: Map of the overlap (red) between FRAs for purse seiners and areas characterised as habitat for Engraulis encrasicolus juveniles.

Table A6: Summary of the representativity results for *Engraulis encrasicolus* spawning and breeding habitat. The first column shows the protection initiative (i.e. the component of the MPA-FRA network) against which representativity was assessed. The second column (area) shows the area overlap the protection initiative and the *Engraulis encrasicolus* spawning and breeding habitat in km^2. The third column gives the percentage of the *Engraulis encrasicolus* spawning and breeding habitat that is protected.

protection	area	%
MPAs	9.29E+009	8.9026046
MPAs (without Pelagos)	9.04E+009	8.6698338
SPAMI	4.04E+009	3.8722622
SPAMI (without Pelagos)	540490866	0.518155
Natura 2000	4.26E+009	4.0851315
FRAs all gear	90527878	0.0867868
FRAs Bottom Trawl	1.62E+010	15.561839
FRAs Pelagic Trawl	3.88E+010	37.216282
FRAs Purse Seine	6.22E+009	5.9600972
FRAs dynamic small scale gear (depth < 1000)	4.08E+009	3.9133542
FRAs passive small scale gear (depth < 1000)	240863279	0.2309096

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