

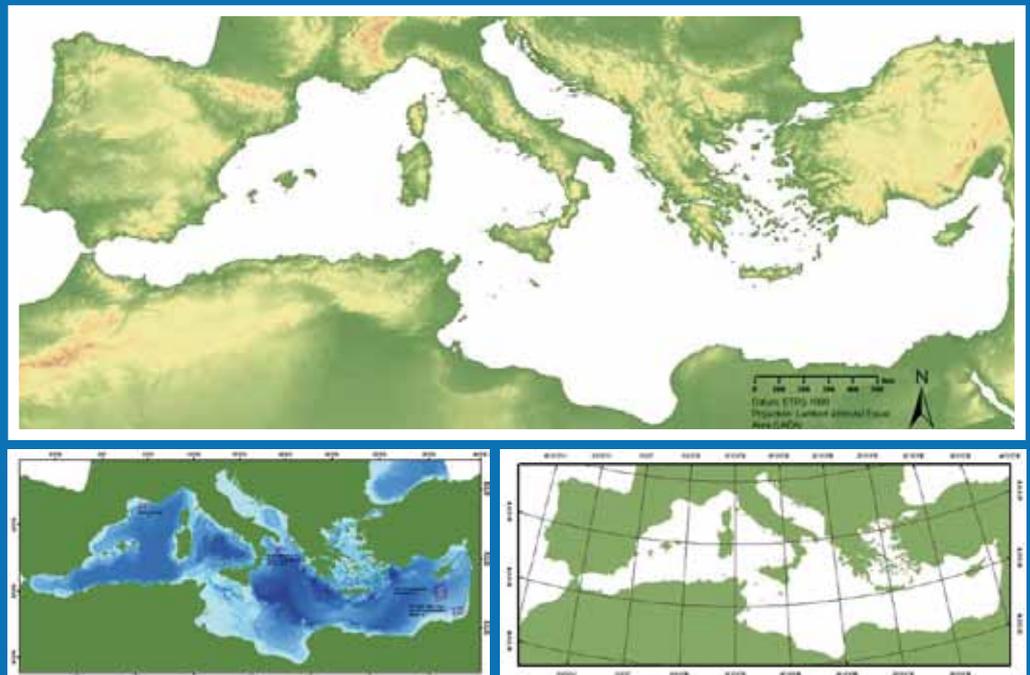


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United Nations Environment Programme
Mediterranean Action Plan
Regional Activity Center for Specially Protected Areas

Technical report on the Geographical Information System developed for the Mediterranean open seas



With financial
support of the European
Commission



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**Technical report on the Geographical
Information System developed for the
Mediterranean open seas**

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Glossary of terms and acronyms

ABNJ. Area beyond national jurisdiction. Namely the *high seas* which refers to international waters or trans-boundary waters. Normally, the ABNJ comprises the water column as well as the seabed and ocean floor and the subsoil thereof beyond the limits of national jurisdiction.

BODC. The British Oceanographic Data Centre is a public facility for looking after and distributing data concerning the marine environment. <http://www.bodc.ac.uk>.

CBD. The Convention on Biological Diversity operates under the United Nations Environment Programme and has three main objectives the conservation of biological diversity, the sustainable use of the components of biological diversity and the fair and equitable sharing of the benefits arising out of the utilization of genetic resources.

CIRCA. The Communication and Information Resource Centre Administrator of the European Environment Agency.

DISC. Data and Information Services Center.

EBSA. Ecologically and Biologically Significant Areas. For designing representative networks of marine protected areas the 9th. Conference of the Parties (COP9) to the Convention on Biological Diversity (CBD) adopted scientific criteria (the CBD EBSA criteria), as well as guidance for this purpose.

EEA. The European Environment Agency of the European Union aims to support the information requirements of EU and international environmental legislation, to make assessments of the European environment and evaluate policy effectiveness; and to improve the coordination and dissemination of environmental data and information about Europe. Some of the recipients of information include the Organisation for Economic Co-operation and Development (OECD), the United Nations Environment Programme (UNEP), the Food and Agriculture Organization (FAO) and the World Health Organization (WHO). The EEA cooperates closely with these organisations in producing information and assessments for its clients and target groups.

EIONET. The European Environment Information and Observation Network aims to provide timely and quality-assured data, information and expertise for assessing the state of the environment in Europe and the pressures acting upon it. Formally, it is a partnership network between the European Environment Agency (EEA) and its members and participating countries and comprises a number of topic Centres (ETCs) and a network of around 900 experts from 37 countries in over 300 national environment agencies and other bodies dealing with environmental information.

FRA. Fisheries Restricted Area.

GEBCO. The General Bathymetric Chart of the Oceans is a publicly available compilation of bathymetry data of the world's oceans. It operates under the joint auspices of the Intergovernmental Oceanographic Commission of UNESCO and the International Hydrographic Organization.

GFCM. General Fisheries Commission for the Mediterranean.

GEODATABASE. A component of a geographic information system to store, query, and manipulate geographic information and spatial data. Vector data can be stored as point, line or polygon data types, and should have an associated spatial reference system.

GES. The Goddard Earth Sciences Division at the United States of North America National Aeronautics and Space Administration (NASA) plans, organizes, evaluates, and implements a broad program of research on Earth natural systems and processes from the perspective of space,

developing and operating remote-sensing satellites and instruments and making data available to scientists. Climate change and the oceans are two of their major focus areas.

GIS. A Geographic Information System (GIS), or Geographical Information System is any system that captures, stores, analyzes, manages, and presents data that is linked to location.

GISCO. Geographic information system of the European Commission.

GNU public license is a widely used free software license. See conditions in <http://www.gnu.org/licenses/gpl-3.0.txt>.

HDF. Hierarchical Data Format. Files in this format, commonly with a HDF extension, comprise a set of file formats and libraries designed to store and organize large amounts of numerical data as well as the images and data provided by remote sensing technologies.

MODIS. The Moderate Resolution Imaging Spectroradiometer aboard the Aqua (EOS PM) satellites provides data related with the oceanic as sea surface temperature or indirect measures of Chlorophyll-a concentration particularly for the development of validated, global, interactive Earth system models.

NASA. The National Aeronautics and Space Administration is a governmental agency of the United States of America.

OSGeo. The Open Source Geospatial Foundation (<http://www.osgeo.org>), is a non-profit organization whose mission is to support and promote the collaborative development of open geospatial technologies and data. The foundation provides financial, organizational and legal support to the broader open source geospatial community. It also serves as an independent legal entity to which community members can contribute with code, funding and other resources, with a guarantee that their contributions will be used for public benefit. The foundation's projects are all freely available and useable under an OSI-certified open source license.

PDF. Portable document file. A file format created by Adobe Systems™ for document exchange.

SeaWiFS. The Sea-viewing Wide Field-of-view Sensor. The SeaWiFS Project purpose is to provide quantitative data on global ocean bio-optical properties to the scientific community. One of the main purposes of SeaWiFS data is to examine oceanic factors that affect global change. Commonly, data provided are being used to help clarify the magnitude and variability of chlorophyll and primary production by marine phytoplankton.

SCUFN. The GEBCO Sub-Committee on Undersea Feature Names.

SPAMI. Specially Protected Areas of Mediterranean Interest are sites of importance for conserving the components of biological diversity in the Mediterranean as defined in Article 8(2) of the 1995 Protocol Concerning Mediterranean Specially Protected Areas and Biological Diversity in the Mediterranean.

TIN. Triangulated irregular network. Basically, it is a vector based representation of the physical land surface or sea bottom, made up of irregularly distributed nodes and lines with three dimensional coordinates x , y , and z (positive or negative) that are arranged in a network of no overlapping triangles.

1. Introduction

A geographical information system (GIS) is possibly one of the most powerful tools to fill the gap between science and decision-making in a complex, large-scale project such as the identification of potential areas for the creation of SPAMI in open seas, including deep seas. A GIS allows to register, organize, compare, transform, analyse and present geographically-referenced information and to maintain this information continuously up-to-date in a permanently ongoing cycle. Thus, information about habitats and species ecology, human activities, resources, and biotic as well as abiotic factors can be studied at any moment in time and as it varies over the geographic area and time.

However, a GIS is much more than a set of layers that overlap over a geographical area. Marine geographical systems have boosted in the last few years, when much work has been done to develop marine data models to facilitate the GIS-based representation and analysis of marine and coastal data types and processes. As a result, geodatabases have become an appropriate tool to store information and data originally in vectorial and raster formats as well as in tables, devices and other supports.

The aim of this project was to prepare suitable contents to help achieve the objectives of the project entitled "*Identification of possible SPAMIs in the Mediterranean areas beyond national jurisdiction*" in close coordination with the RAC/SPA staff and other consultants. The contents provided were compiled and analysed. Georeferenced files (shapefiles format (.shp) and .kmz files for GoogleEarth™ display) and map layouts in editable Adobe™ portable document file (pdf) high-resolution format have been produced.

Much of the information compiled for this project was freely available. This includes a wide range of data, from software to raw and processed information: the Quantum GIS Project, the Open Source Geospatial Foundation Project, the SeaWiFS and the MODIS Projects, the NASA Goddard Earth Sciences (GES) Data and Information Services Center (DISC), BirdLife International database, the GEMCO team and the British Oceanographic Data Centre (BODC), the European Environment Agency (EEA) and both the European Environment Information and Observation Network (EIONET), and the Communication and Information Resource Centre Administrator (CIRCA), the GoogleEarth™ community etc.

2. General methodology Initial assumptions

The model designed at the onset of this project, was meant to be able to handle a large territorial scale such as the Mediterranean sea, to allow for non-expert use and management of georeferenced information and for its continuous updating and extension, to be compatible with personal computers with basic requirements of memory and space and to show flexibility to be transformed into other systems (eg. geographical projections, new formats such as .kml, etc.). At this initial stage, it was also taken into account that the compiled information on several marine aspects would be provided by contributors in several formats by contributors: images from previously published maps, geographical coordinates from legal regulations, files from GoogleEarth™ and other systems that would have to be integrated into a straightforward, flexible and scalable structure of the geodatabase from the beginning of the project.

2.2. Software used

For the initial process of compiling, scaling to the Mediterranean area and basic edition of layers, Quantum GIS (<http://www.qgis.org>), an open–source GIS program distributed under GNU public license, was chosen. Among other interesting features, this software has a great processing potential and an optimal memory management (being, thus, sufficiently stable to deal with large files and time and hardware-demanding editing processes) as well as “ready-to-use” filters to import and export between different GIS files formats including shapefiles, Google™ kml or HDF raster images (which are very useful for the initial treatment of SST and Chlo-a raster images). Additionally, other tools that can be interest for the purpose of this work are continuously being developed and improved by a wide web of developers. One of this is “fTools 0.5.9”, a resource kit for many common vector-based GIS tasks as geoprocessing tools (joining, buffering, intersecting, clipping, merging...). Other possibilities include joining attributes, compiling basic statistics over attribute fields and generating regular grids of points, lines or polygons (<http://www.ftools.ca/fTools.html>).

For the building of the geodatabase, certain processes and the final layout edition the ESRI ArcView™ system was used, as well as some extensions and tools specifically developed for this suite by the EIONET as stylesheets for viewing XML metadata files following EEA Metadata Standard for Geographic Information (EEA-MSGI) and a specifically developed package of tools for this suite designed to deal with metadata. Also a tool to create a polygon or line shapefile grid (fishnet) with a ETRS-LAEA grid in accepted size, as defined by EEA was implemented (see figure 1).

Almost all the work done with data provided by remote sensing –Sea Surface Temperature (SST), Chlorophyll-a concentration, etc.– was achieve with the use of the “*Marine Geospatial Ecology Tools*” (MGET). Equally known as the “GeoEco Python package”, this is an open source geoprocessing toolbox specially designed for coastal and marine information and oceanographic analysis. For this kind of information, another useful tool was HDFView, a free software tool for browsing and editing HDF4 and HDF5 files developed by The National Center for Supercomputing Applications (NCSA) at the University of Illinois (The HDF Group).



Figure 1. Non-profit and public software and information providers.

Logo 1. Quantum GIS, abbreviated QGIS (<http://www.qgis.org>), is a user friendly Open Source Geographic Information System (GIS) licensed under the GNU General Public License. QGIS is an official project of the Open Source Geospatial Foundation (OSGeo). It runs on Linux, Unix, Mac OSX, and Windows operative systems and supports numerous vector, raster, and database formats and functionalities.

Logo 2. The non-profit HDF Group, whose mission is to ensure continued development of HDF technologies, and the continued accessibility of data currently stored in the HDF Hierarchical Data Format. HDF files are designed to store and organize large amounts of numerical data as satellite images provide. Files can be read and analysed by means of specific software such as HDFView, a visual tool for browsing and editing HDF4 and HDF5 files. Many organizations in both the public and private sectors use HDF to meet long term, mission critical data management needs as the NASA.

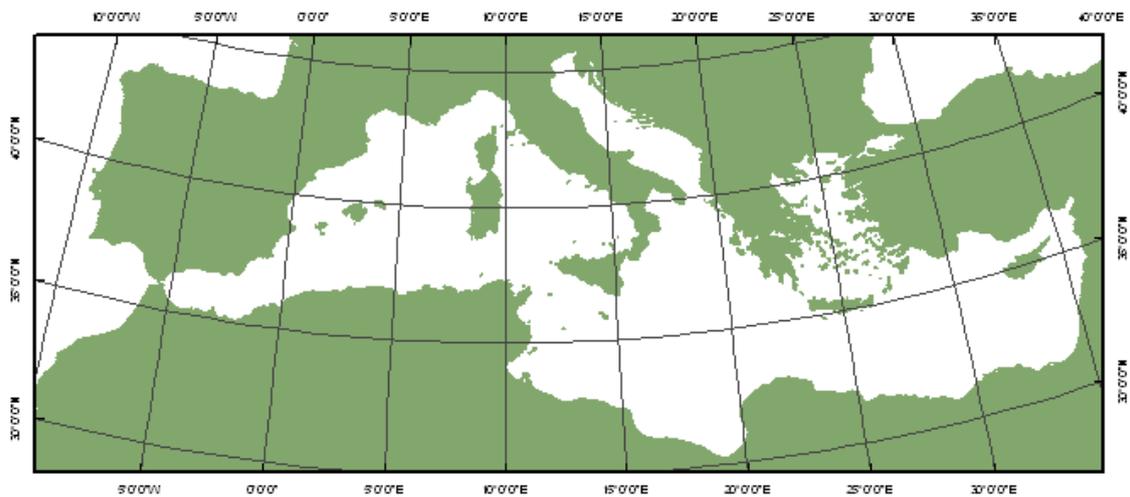
Logo 3. The European Environment Information and Observation Network aims to provide timely and quality-assured data, information and expertise for assessing the state of the environment in Europe and the pressures acting upon it. Formally, its is a partnership network of the European Environment Agency (EEA) and its member and participating countries and comprises a number topic Centres (ETCs) and a network of around 900 experts from 37 countries in over 300 national environment agencies and other bodies dealing with environmental information.

2.3. Datums and geographical projections

Following the INSPIRE Directive (*Infrastructure for spatial information in Europe* (<http://inspire.jrc.ec.europa.eu/>) and the European Environmental Agency guidelines as much as possible, the European Terrestrial Reference System 1989 (ETRS89) was used as geodetic datum for pan-European spatial data collection, storage and analysis. Also, following the European Commission recommendation the Lambert Azimuthal Equal Area (ETRS89-LAEA; 52 N, 10 E, false easting: 4 321 000, false northing: 3 210 000) projection was selected due to its suitability for storing raster data, for statistical analysis and for map display purposes. Moreover, this is the EEA projection recommended for spatial analysis, e.g. grid analysis, as this is an area-true projection and it is recommended for use when combining layers, measuring areas and distances, and in sampling processes for statistical purposes.

As one of the expected outputs for this compilation was a suit of .kmz files that would allow to be viewed in Google Earth™, all the concluded shapefiles were also converted to the WGS-84 datum. In this way, a double objective was accomplished: .kmz files were produced with a high accuracy and final users could have a set of layers in the Geographic Coordinate System (GCS) WGS-84. This datum is one of the most extended in the world and widely used in GPS and other positioning devices. However, this is not recommended to use it to measure distances. On the other hand, the transformation between WGS-84 and ETRS and vice versa is straightforward for our purposes (see fig. 2)

A



B

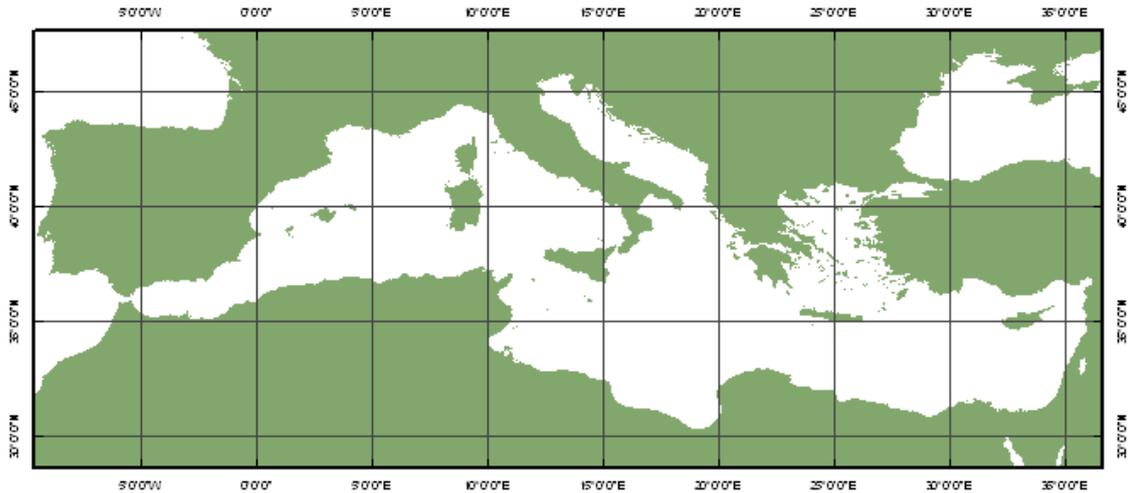


Figure 2. The map A is a layout of the Mediterranean Sea basin in the Lambert Azimuthal Equal Area (LAEA) coordinate system and ETRS89 (ETRS-LAEA) datum. This is the common EEA and ETCs system for storage, analysis, map production and delivery. For a wide statistical spatial analysis, e.g. grid analysis, the EEA recommends using ETRS-LAEA, 52 N, 10 E as this is an area-true projection. It should be used when combining layers, measuring areas and distances, and in sampling processes for statistical purposes.

The B layout is the result of using the WGS84 datum. It was chosen as a secondary coordinate reference system. Although any reference vector data should be stored as WGS84 datum, it is not suitable for map display purposes, nor analysis. Nevertheless, it is easily transformable to ETRS89 and widely used, ie. in GPS devices, it is the GoogleEarth datum, among other practical reasons.

2.4. Gridding data

The use of spatial grids use is widely recommended for the visualisation, analysis and the fine-tuning of spatial indices in the data repository. This procedure not only ensures that each feature enclosed in the cell will be processed for statistical purposes once (when it is properly indexed) but also improves the performance of complex processes like table querying, joining attributes, etc. The use of spatial grids has another advantage for the purpose of this study as they average the qualitative properties of the different objects collected from the variety of information sources used. Grids are powerful tools for harmonising and reducing the complexity of spatial datasets and many recent projects dealing with georeferenced information and aimed to the identification of marine protected areas (MPA) in open seas have chosen this methodological approach, such as the European Union “EMPAFISH: Marine protected areas as tools for fisheries”, the “MESH: Mapping European Seabed Habitats” (<http://www.searchmesh.net>) and the UK Joint Nature Conservation Committee (JNCC) project “Identification of nationally important marine areas in the Irish Sea”, among others.

An equal area grid has been chosen for this project because it is suitable for generalising data, statistical mapping and analytical work. From a Pan-Mediterranean geographical scope, the use of the multipurpose European grid based on Lambert Azimuthal Equal Area using coordinate reference system ETRS89 with latitude of origin 52 N and longitude of origin 10 E (ETRS-LAEA), is an appropriate election.

In general terms, generalisation of the grid to larger cells is a recommended procedure, considering that resolution of the selected grid must correspond to spatial variability of the mapped feature and its geographical “uncertainty”. In this way, only relevant details are captured, and “repeated” values are minimized. After testing several different resolutions and considering the disparity in the original data, a 10 x 10 km square cell (thus 100 km²) was the adopted as the best solution. So once only the marine portion of each cell was retained, the Mediterranean basin extension resulted in a 26,736 cells grid covering 2,525,138.004 km². Oceanographic factors were translated into this Mediterranean grid using different procedures of spatial join, obtaining different grids collecting information on depth, Chlo-a concentration, SST, as well as the area covered, as it would be required for the purposes of this project. Each of the cells has a unique code (the ‘cellcode’) that identifies resolution, row and column following the EEA operational guide to geographic data and maps. This methodology was successfully applied to the “*Georeferenced compilation on bird important areas in open seas in the Mediterranean region*” consultation done under RAC/SPA contract N° 33/2009. Another 50 x 50 km square cell grid has been prepared for a more coarse analysis of data.

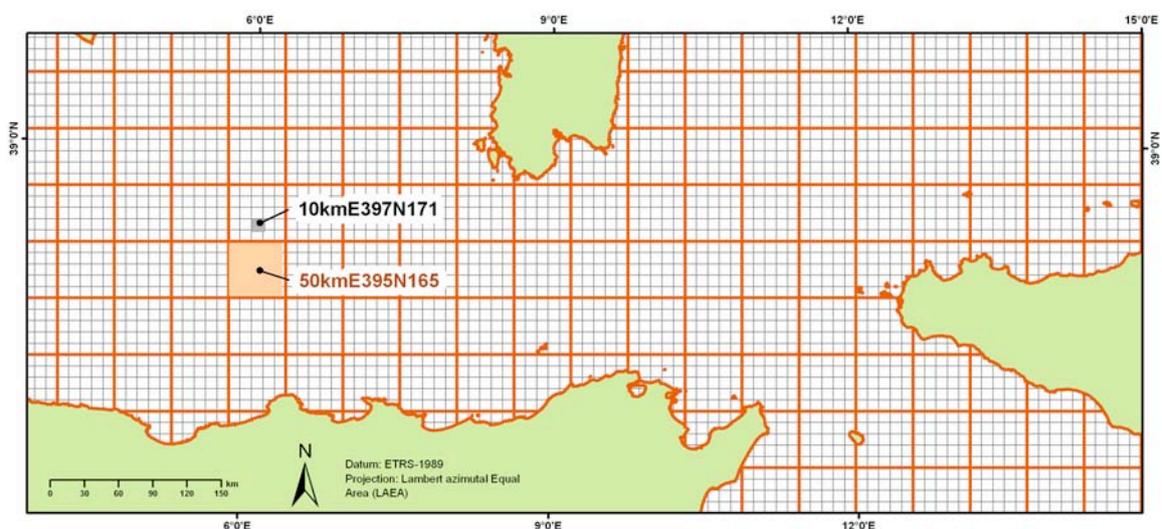


Figure 3. The map is a layout of an area of the Mediterranean Sea basin with the two gridsets overlaid. Orange cells (bigger squares) represents the 50 x 50 km square cell grid. Grey and smaller cells are the 10 x 10 km square cell grid. A ‘cellcode’ identifies resolution, row and column of each cell, acting as an index and permits to pivot information from different sources (depth, species presence, Chlo-a concentration, SST or fish effort).

2.5. Metadata

Metadata (information about a data file/dataset) should accompany every GIS dataset. It is a very important component and it can be very difficult to accurately interpret the information that the data provides valuable information about how it could be used.

As far as possible, the specifications, guidelines and tools for handling metadata developed by the EEA have been applied: the “European Environment Agency Metadata Standard for Geographic Information (EEA-MSGI). Figure 4 shows a typical data datasheet ready to be incorporated to a database.

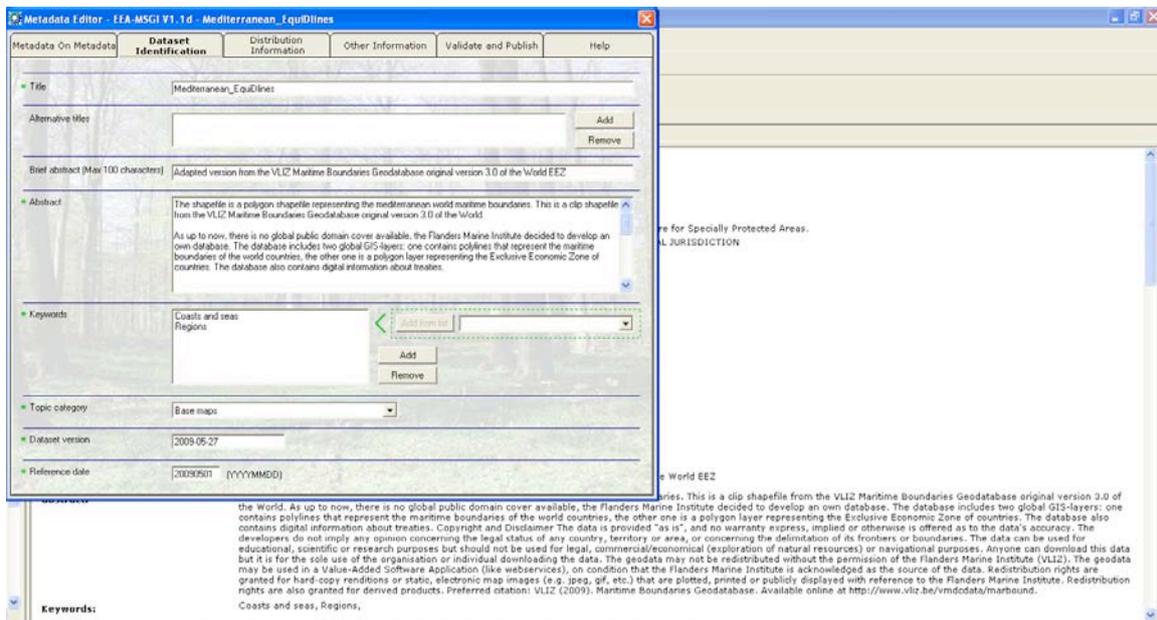


Figure 4. The EEA metadata editor provides easy editing and validation of metadata using the ArcCatalog™ application environment.

2.6. Information compilation

The information collected came in a wide variety of possible formats: published maps in graphic formats (eg. .jpg pictures), raw geographical localizations tables, Google™ KML files or previous works in GIS formats. An effort was made, as far as possible, to use existing datasets endorsed by public institutions such as the European Commission (as GISCO Database, a permanent service of EUROSTAT to manage and disseminate the geographical reference database of the Commission) and the EEA data service EIONET (European Environment Information and Observation Network). Other source datasets were found via geoportals or data distributors, e.g. NGDC (U.S. National Geophysical Data Center) or from datasets about geographical information e.g. GEBCO (General Bathymetric Chart of the Oceans of U.K.).

Some of the information had been previously prepared by various RAC/SPA consultants and was submitted in order to be added to this compilation, while other data were produced “*ex novo*”. Sometimes information was provided in different cartographical projections or even unknown systems with no additional information, so a “trial and error” process had to be performed until a satisfactory result was reached.

In the initial phase, all this information was prepared into a GIS-format using basic appropriate features (points, polylines or polygons) depending on the nature of data and in shapefile (.shp) files. In successive phases, some cases were re-processed and more transformations were performed (eg. from polyline to polygon, from grid to TIN to raster, etc). Most of the intermediate products have been kept in the final compilation.

2.7. The geodatabase structure

The dataset structure follows a hierarchical structure giving coherence to the information in the geodatabase. In fact, a geodatabase can be seen as a collection of vertically integrated geodatasets. Each feature dataset consists in a folder of vectorial layers (shapefiles, tables, text files, etc) with the ETRS-LAEA coordinate system defined. In this way, the feature classes (polygons, polylines, points, etc) contained, share the same spatial reference properties, and different geospatial queries can be performed setting the relations between the feature classes, both vertically and horizontally. Figure 5 illustrates the final structure and purposes of the feature datasets.

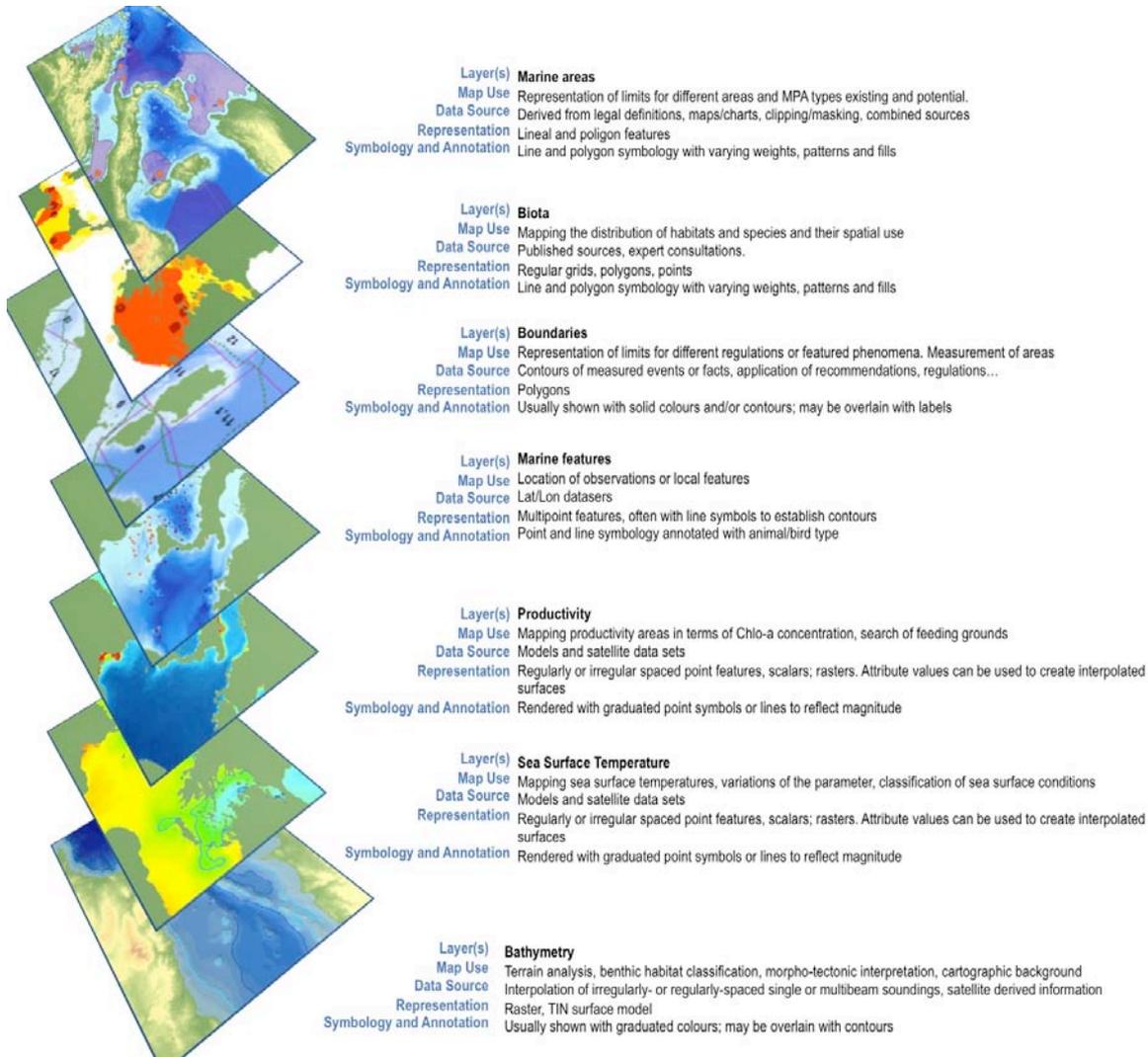


Figure 5. A geodatabase is a vertically integrated geodatasets and geographically related over an area. Between geodatasets multiple logical queries and arithmetic calculations can be performed. Representation adapted to this compilation from Wright et al. (2007).

3. Compilation

3.1. Boundaries

3.1.1. EquiLines

Layer(s): Mediterranean_EquidLines.shp

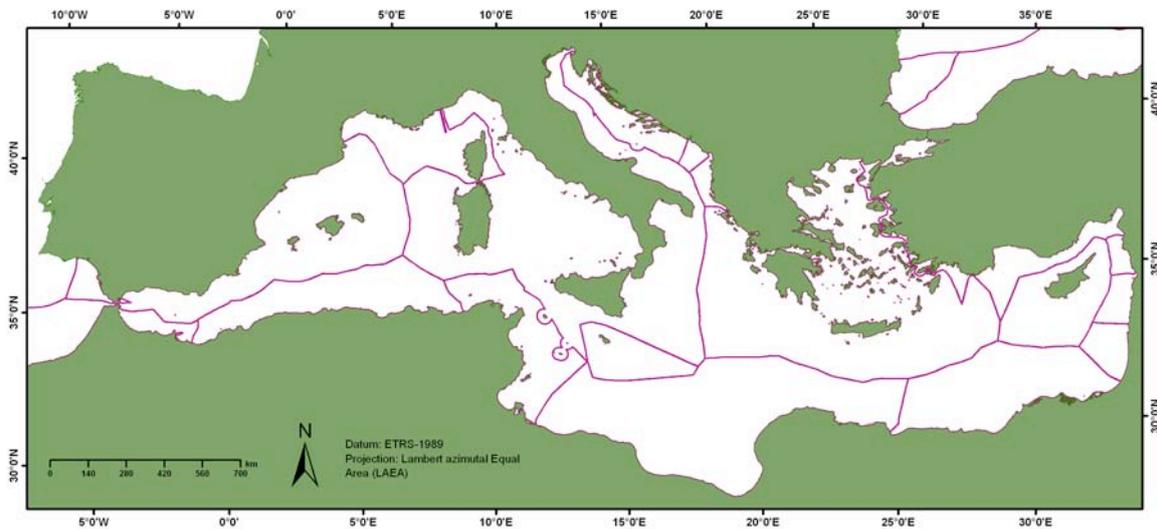


Figure 6. Adapted version of the VLIZ Maritime Boundaries Geodatabase original version 3.0 of the World.

Adapted version from the VLIZ Maritime Boundaries Geodatabase original version 3.0 of the World's Exclusive Economic Zones or EEZs (polyline and polygons). This polygon shapefile represents maritime equidistance lines of Mediterranean countries. Over the VLIZ Maritime Boundaries Geodatabase original version 3.0 of the World, a clipping process was performed over the Mediterranean Sea. Since, there is no global public domain cover available to date, the Flanders Marine Institute VLIZ decided to develop their own database. The Flanders database includes two global GIS-layers: one for polylines that represent the maritime boundaries of the world's countries; the other one is a polygon layer representing the Exclusive Economic Zone of countries. The database also contains digital information about international treaties on the subject of territorial boundaries and is available online at <http://www.vliz.be/vmdcdata/marbound>.

The copyright and disclaimer of the original geodatabase specify that data are provided "as is", and no warranty express, implied or otherwise is offered as to the data accuracy. The database developers also announce that they do not imply any opinion concerning the legal status of any country, territory or area, or concerning the delimitation of its frontiers or boundaries. The data can be used for educational, scientific or research purposes. The geodata may not be redistributed without the permission of the Flanders Marine Institute (VLIZ) but may be used in a Value-Added Software Application (like web services), on the condition that the Flanders Marine Institute is acknowledged as the source of the data. Redistribution rights are granted for hard-copy renditions or static, electronic map images (e.g. jpeg, gif, etc.) that are plotted, printed or publicly displayed with reference to the Flanders Marine Institute. Preferred citation: VLIZ (2009). Maritime Boundaries Geodatabase. Redistribution rights are also granted for derived products.

3.1.2. FAO

Layer(s): GFCM_GSA_pol.shp; GFCM_GSA_In.shp

The General Fisheries Commission for the Mediterranean (GFCM) mandate covers the development, conservation, rational management and best utilization of living marine resources, as well as the sustainable development of aquaculture in the Mediterranean region. To compile data, monitor fisheries and assess fisheries resources in relationship with the geographical space has established 30 Geographical Sub-Areas (GSAs). These layers compile the areas both as polygons and as polylines. Georeferencing has been accomplished following the Resolution GFCM/33/2009/2 except for the areas 28 (Marmara Sea), 29 (Black Sea) and 30 (Azov) that have been excluded, as they are out of the geographical boundaries of this project. It has been assumed that original coordinates are given in the WGS-84 geographic coordinate system (ftp.fao.org/ FI/ DOCUMENT/ gfcml meetings/GFCM_GSA_2009_coordinates.pdf).

Thus areas thus represented are:

Code	Name	Area (km ²)	Code	Name	Area (km ²)
1	Northern Alboran Sea	33027.23	14	Gulf of Gabes	52155.16
2	Alboran Island	2225.15	15	Malta Island	26767.98
3	Southern Alboran Sea	22688.83	16	South of Sicily	37534.05
4	Algeria	126784.22	17	Northern Adriatic	84758.52
5	Balearic Island	113975.36	18	Southern Adriatic Sea	51811.27
6	Northern Spain	101532.07	19	Western Ionian Sea	167094.58
7	Gulf of Lions	61992.95	20	Eastern Ionian Sea	124506.52
8	Corsica Island	25448.49	21	Southern Ionian Sea	365867.63
9	Ligurian and North Tyrrhenian Sea	53947.26	22	Aegean Sea	220633.74
10	South Tyrrhenian Sea	133934.37	23	Crete Island	62685.09
11.1	Sardinia (west)	67684.40	24	North Levant	99906.40
11.2	Sardinia (east)	58159.47	25	Cyprus Island	45070.54
12	Northern Tunisia	39066.88	26	South Levant	258257.88
13	Gulf of Hammamet	37882.38	27	Levant	36588.69

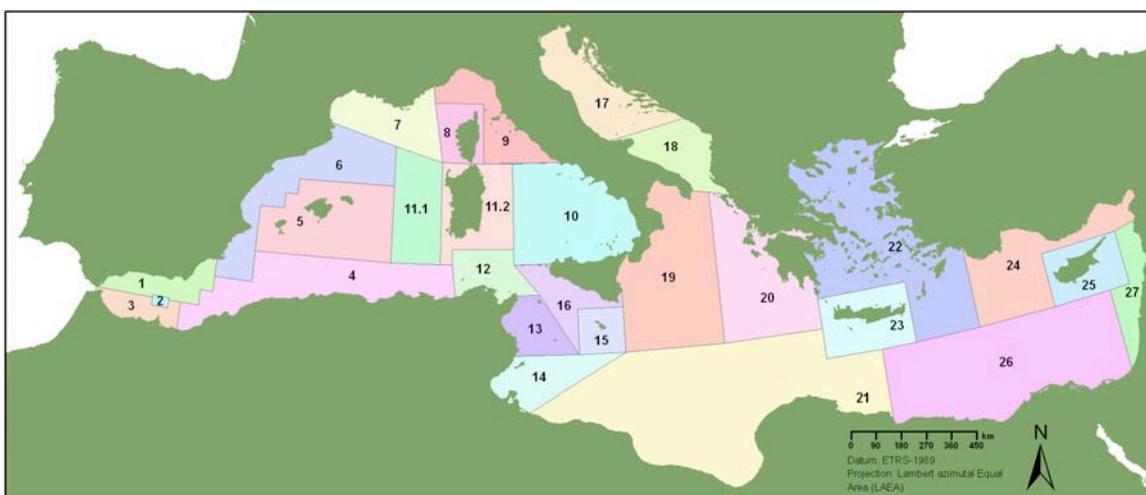


Figure 7. Geographical Sub-Areas (GSAs) of the General Fisheries Commission for the Mediterranean (GFCM).

3.2. Shoreline

Layer(s): GSHHS_shoreline_In.shp. Polyline. A high-resolution shoreline data set; gshhs_CONTINENTS.shp. Polygon based in the GSHHS shoreline data set.

The Global Self-consistent Hierarchical High-resolution Shorelines (GSHHS) data set, by Paul Wessel and Walter H. F. Smith, provides a consistent set of hierarchically arranged closed polygons. They can be used to construct base maps, or in applications or analyses that involve things like geographic searches or the statistical properties of coastlines. This shoreline data set comes from the amalgamation of two databases in the public domain: the World Data Bank (WDB) and the World Vector Shoreline (WVS) database. The first database is the reference for political boundaries and the second for shorelines and land/water boundaries. The data have undergone extensive processing and are free of internal inconsistencies such as erratic points and crossing segments. The shorelines are constructed entirely from hierarchically arranged closed polygons. The data can be used to simplify data searches and data selections, or to study the statistical characteristics of shorelines and land-masses. It comes with access software and routines to facilitate decimation based on a standard line-reduction algorithm. The original product was originally derived from a global set of 3-second rasterized image maps (e 1:250,000).

The geographic range of Coastline was extracted from the NOAA National Geophysical Data Center (NGDC) using the Coastline Extractor. The latter was created by Rich Signell of the U.S. Geological Survey / Geologic Division / Coastal and Marine Program / Woods Hole Field Center. The extractor pages are currently hosted by the NOAA/National Geophysical Data Center, Marine Geology and Geophysics Division. The selected data returned by the query is an ASCII flat file with two columns containing longitude and latitude in decimal degrees (west negative). The original world extension of shorelines have been clipped to the Mediterranean extension and reprocessed (vg. projected and converted into polygons) as required for the present project purposes.

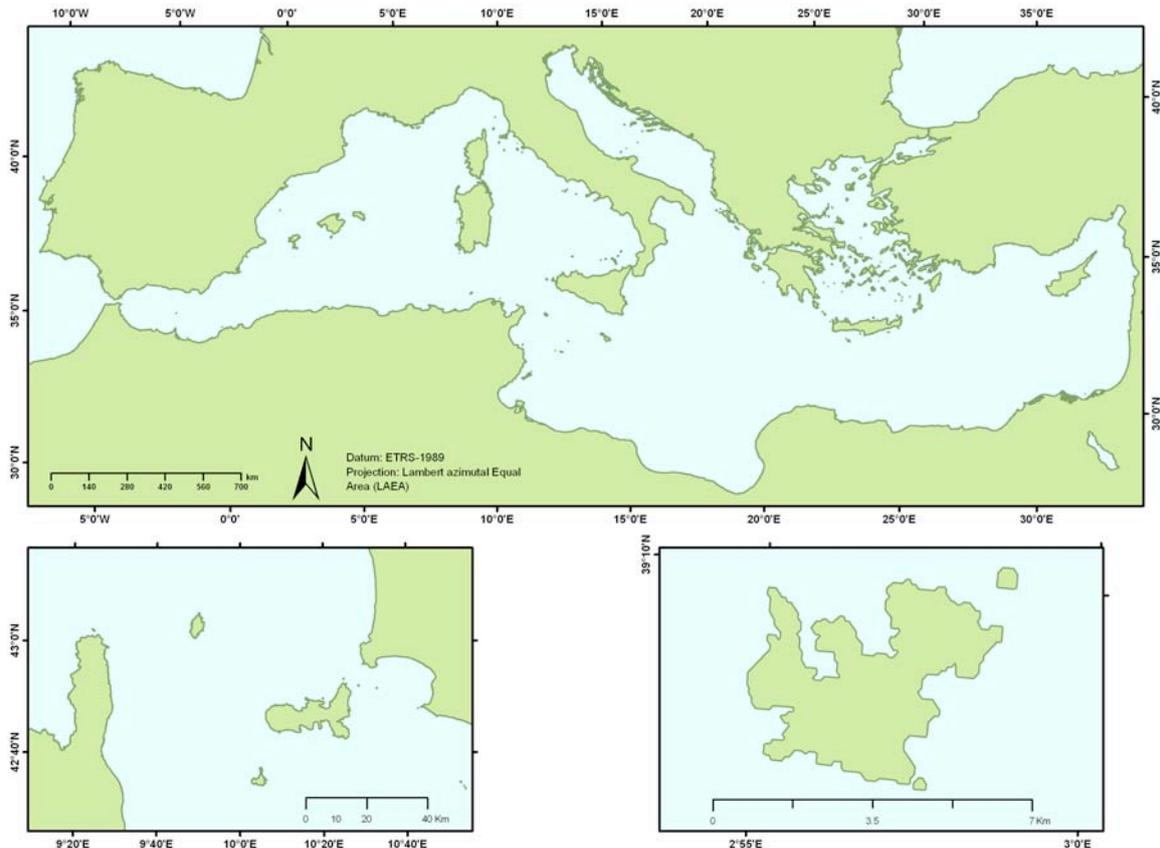


Figure 8. Global Self-consistent Hierarchical High-resolution Shorelines (GSHHS) data set.

3.3. Bathymetry

3.3.1. Meshdata

Layer(s): Bathy_Med_mesh_cells.shp.

Raw xyz grid provided by the GEBCO One Minute Grid (version 2.0 released in Nov 2008), with 1.008.036 values, downloaded from <http://www.bodc.ac.uk/data/online> delivery. This dataset is a continuous digital terrain model for ocean and land, with land elevations derived from the Global Land One-km Base Elevation (GLOBE) database. The data were extracted from the version 2.0, released in November 2008. The gridded data are stored in a netCDF data file compatible with the Generic Mapping Tools (GMT) system. The grid arrays 2-byte signed integer values of elevation in metres, with negative values for bathymetric depths and positive values for topographic heights. The original data were downloaded considering the Mediterranean set divided in four quadrants. This final layer is the result of merging this previous four after the exclusion of data over 5 positive meters high. A zoom over this layer is shown in figure 9.

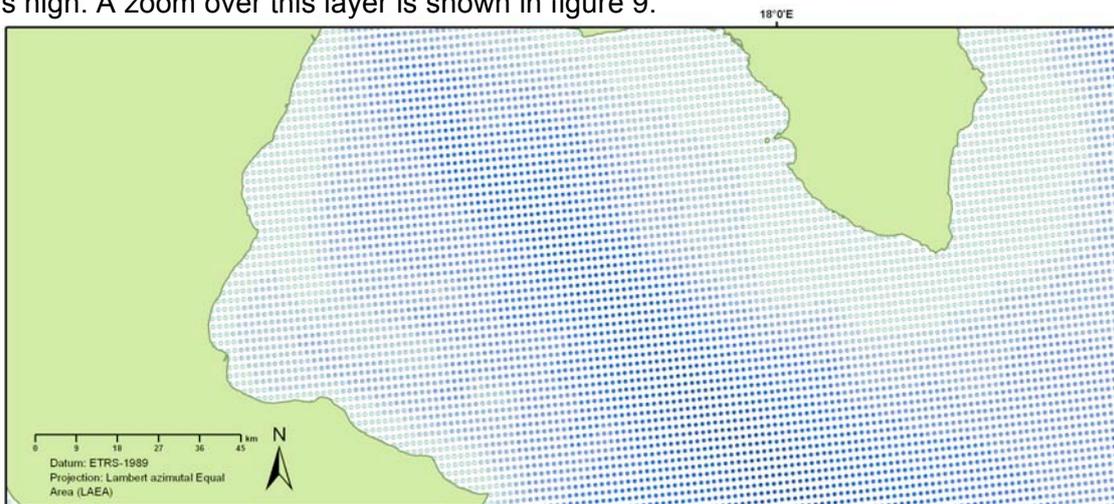


Figure 9. A detail over the Ionian Sea area of the “Bathy_Med_mesh_cells.shp” layer.

3.3.2. Grid

Layer(s): Bathy_Med_mean_grid.shp. Averaged data from the General Bathymetric Chart of the Oceans (GEBCO) one-minute grid over the 10 Km Eunis ETRS_LAEA grid and categorised by pelagic habitats (fig. 10).

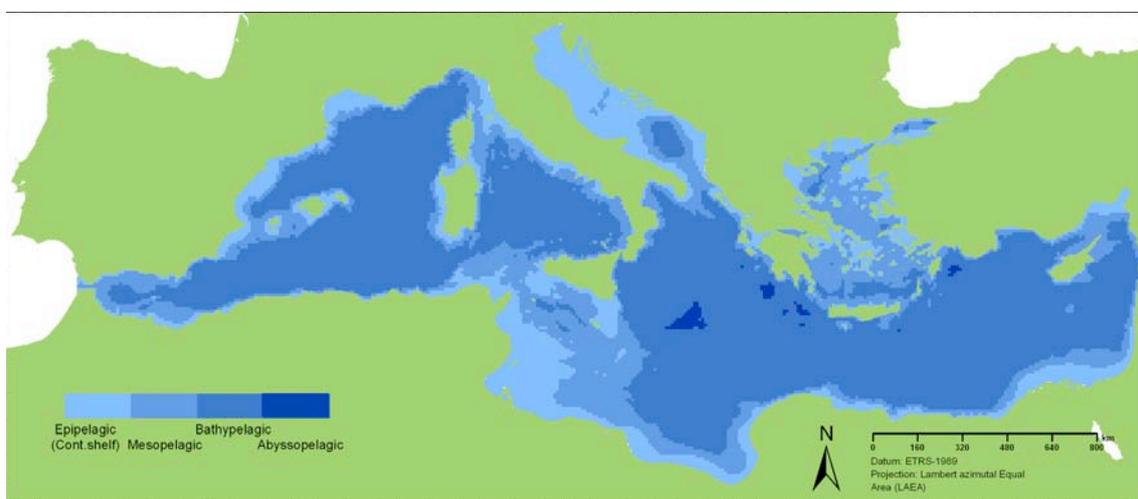


Figure 10. “Bathy_Med_mean_grid.shp” layer and the layout of the bathymetric 10 km grid over the Mediterranean basin.

From the original xyz grid provided by the GEBCO One Minute Grid (version 2.0 released in Nov 2008), a spatial join performed on the 10 Km ETRS-LAEA grid. Each set of points in every cell was subsequently averaged in order to obtain a unique value for each cell (centroid).

Thus from 1,008,036 values (Bathy_Med_mesh_cells.shp layer) a new averaged layer with 29,169 points was produced. Only cells below 5 m depth were retained. Finally a new field (Pelagichab) was added classifying each cell as Land, Epipelagic (continental shelf), Mesopelagic, Bathypelagic and Abyssopelagic. All these operations were performed in the ETRS89 Lambert Azimuthal Equal Area 52N 10E projection, recommended for reference grids by the European Environment Agency. The process is explained through figures 11 and 12.

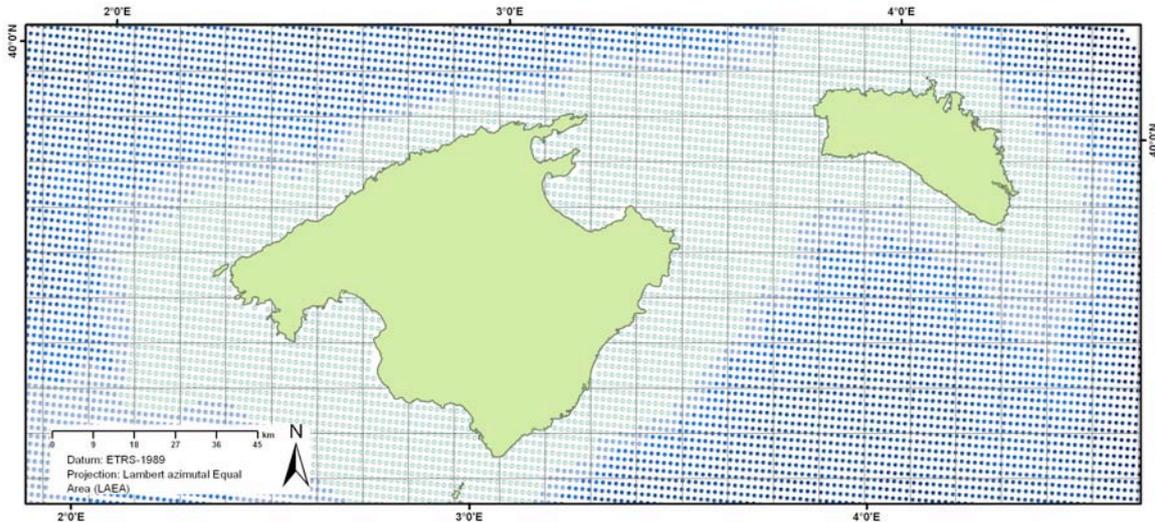


Figure 11. Over the previous layer the 10 Km ETRS-LAEA grid was applied in order to extract an averaged depth for each cell.

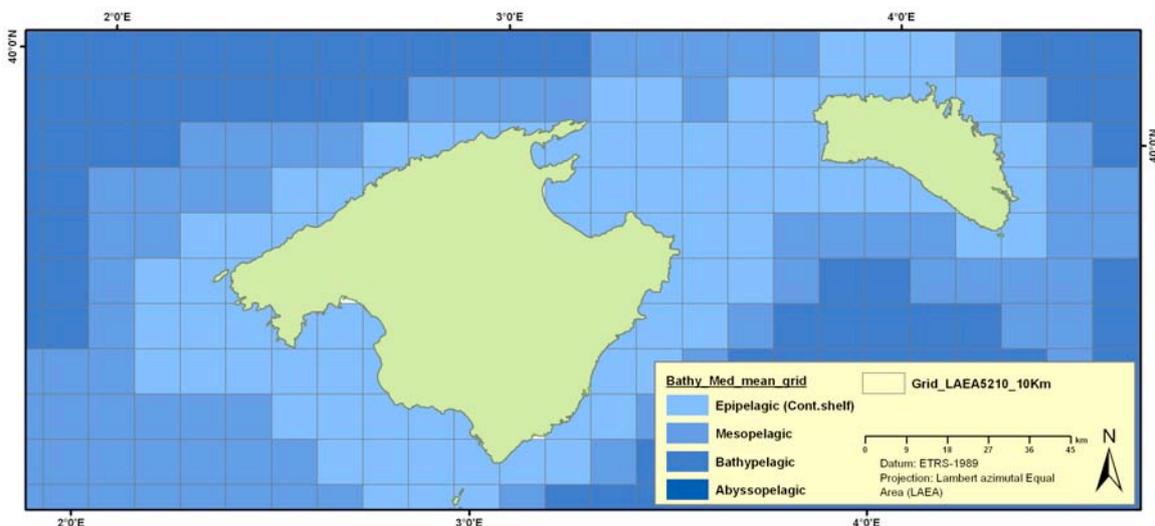


Figure 12. The resulting layer after the assignation of an averaged value for each 10 km cell. A further classification was performed using a new field (Pelagichab).

3.3.3. Isobaths

Layer(s):

- Isobaths_cntrs_Med.shp. Polylines. A bathymetric contour set of the Mediterranean Sea from the GEBCO One Minute Grid (Fig. 13).

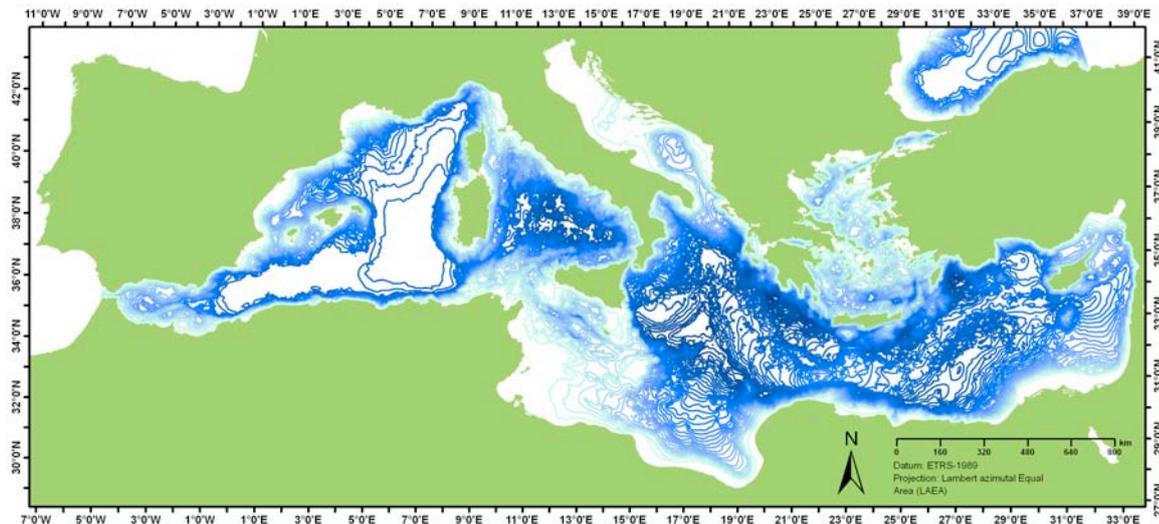


Figure 13. A layout of the bathymetric contours from the GEBCO One Minute Grid.

The original xyz grid provided by the GEBCO One Minute Grid (version 2.0 released in Nov 2008) was adjusted to the area covered in this project. From an original set of 1,008,036 values (points) (see Bathy_Med_mesh_cells.shp layer), a new averaged layer with 29,169 points was produced after its application over the 10 Km grid (ETRS89 Lambert Azimuthal Equal Area 52N 10E projection, recommended for reference grids by the European Environment Agency). Only cells below 5 m depth were retained. From these centroids, the 100 m isobaths were extracted and assembled.

This shapefile may contain inconsistencies and should only be considered for illustrative-orientative purposes. For a thoroughly tested bathymetric contour set of the Mediterranean Sea, the IBCM set provided by the Centenary Edition of the GEBCO Digital Atlas (GDA) is highly recommended: http://www.gebco.net/data_and_products/gebco_digital_atlas

- Bathy_IBCM_Med.shp. Bathymetric contours from the Centenary Edition of the GEBCO Digital Atlas.

This set of Mediterranean isobaths was extracted from the GEBCO IBCM data set published by GEBCO (IOC, IHO and BODC, 2003), The Centenary Edition of the GEBCO Digital Atlas, published on CD-ROM on behalf of the Intergovernmental Oceanographic Commission and the International Hydrographic Organization as part of the General Bathymetric Chart of the Oceans, British Oceanographic Data Centre, Liverpool, U.K.

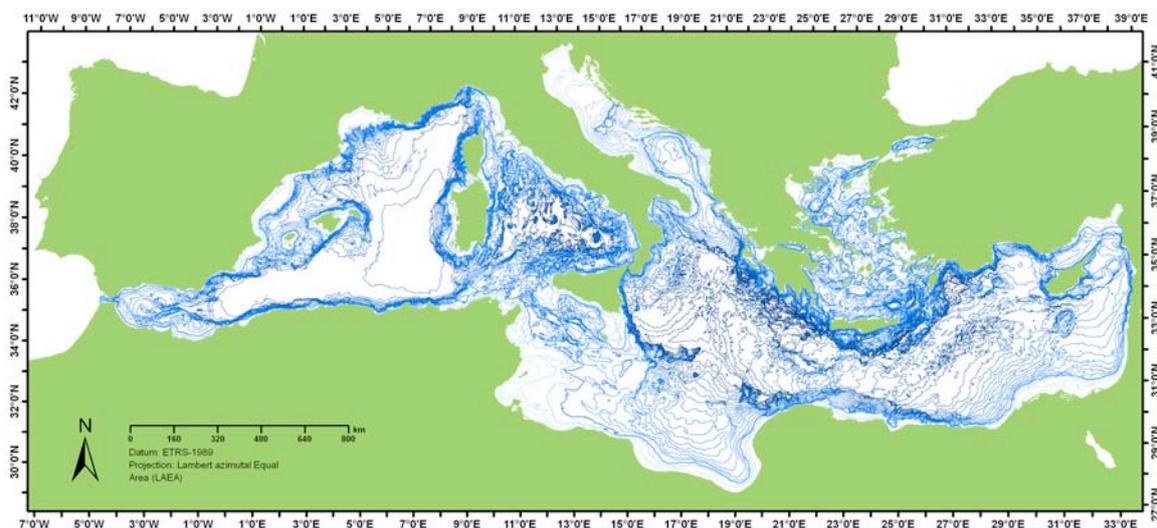


Figure 14. A layout of the bathymetric contours from the GEBCO from the Centenary Edition of the GEBCO Digital Atlas.

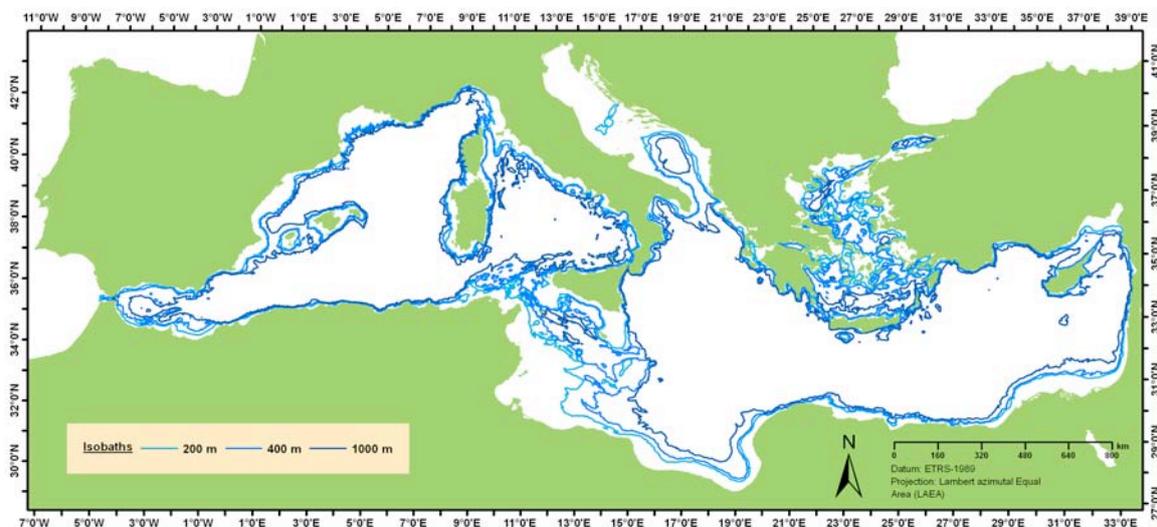


Figure 15. A special layout showing only the 200, 400 and 1000 isobathic contours. These are the limits imposed by different fisheries regulations for certain activities and fishing gears as the 1.000 m depth prohibition on towed dredges and trawl nets (Recommendation GFCM/2005/1), the Council Regulation (EC) No 1967/2006 of 21 December 2006 for the prohibition of the use of towed dredges and trawl nets fisheries at depths beyond 1 000 m, or the exploitation of fishery resources in the Mediterranean Sea, 400 m depth considered for the "Review of the management of deep-sea fish stocks" (COM(2007) 30 final).

3.3.4. TIN

A triangulated irregular network (TIN) is used in a geographic information system (GIS) for the representation of a surface. Commonly used for the surface representation of the sea bottom, TINs have the advantage of being able to portray terrain in three dimensions.

Layer(s):

- bathy_tin_east.shp. Bathymetric surface derived from a triangulated irregular network (TIN) of the GEBCO One Minute grid data. Eastern Mediterranean basin. West bound longitude: -6. East bound longitude: 15. North bound latitude: 45,8333. South bound latitude: 32,4333.

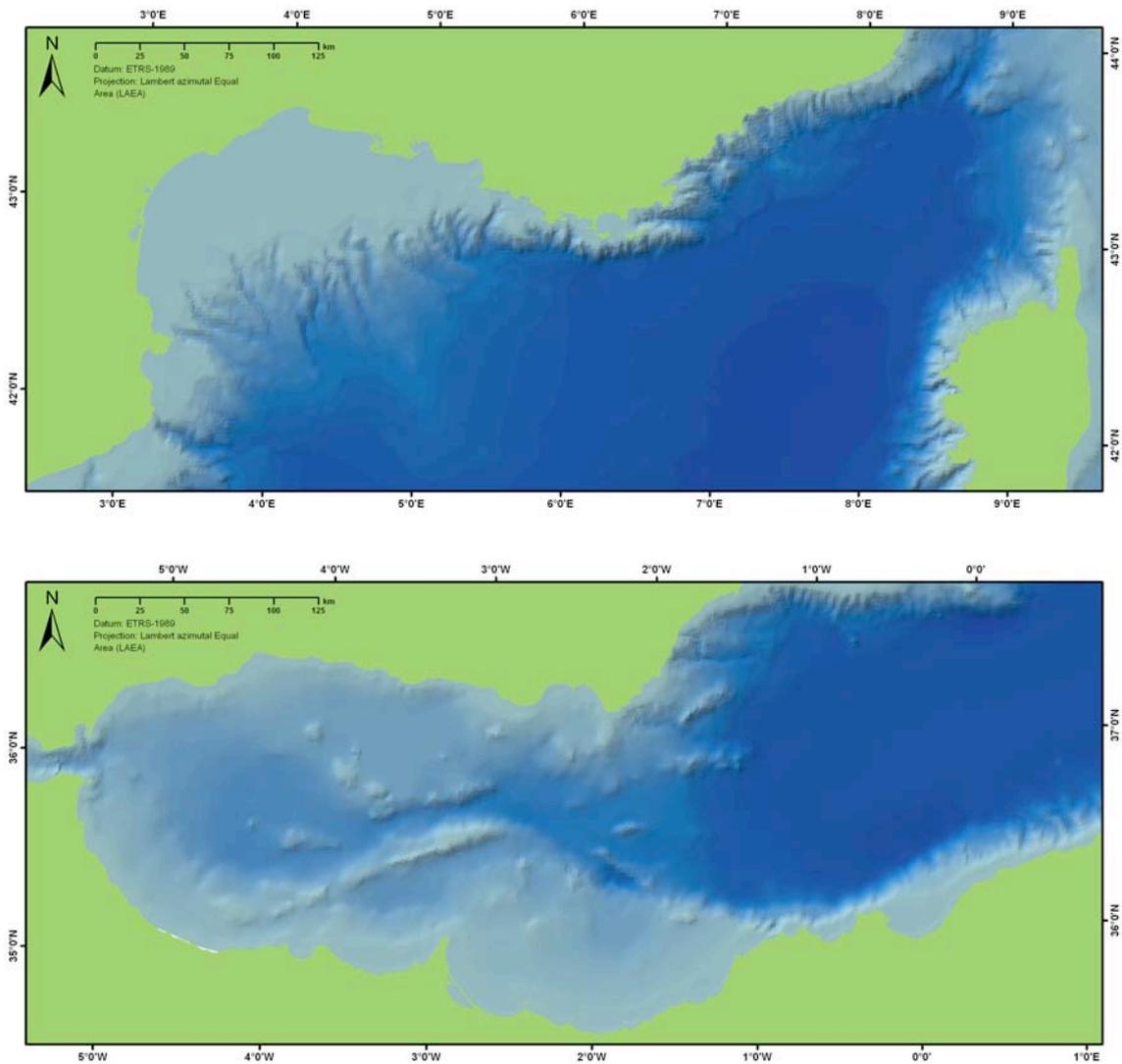


Figure 16. A zoom over the northwest sector of this layer, showing the Gulf of Lion canyon system (upper image) and the southwest sector and the Alboran Sea seamounts and volcanic pits (lower image).

- bathy_tin_west.shp. Bathymetric surface derived from a triangulated irregular network (TIN) of the GEBCO One Minute grid data. Western Mediterranean basin. West bound longitude: 15. East bound longitude: 36,5. North bound latitude: 46. South bound latitude: 30.

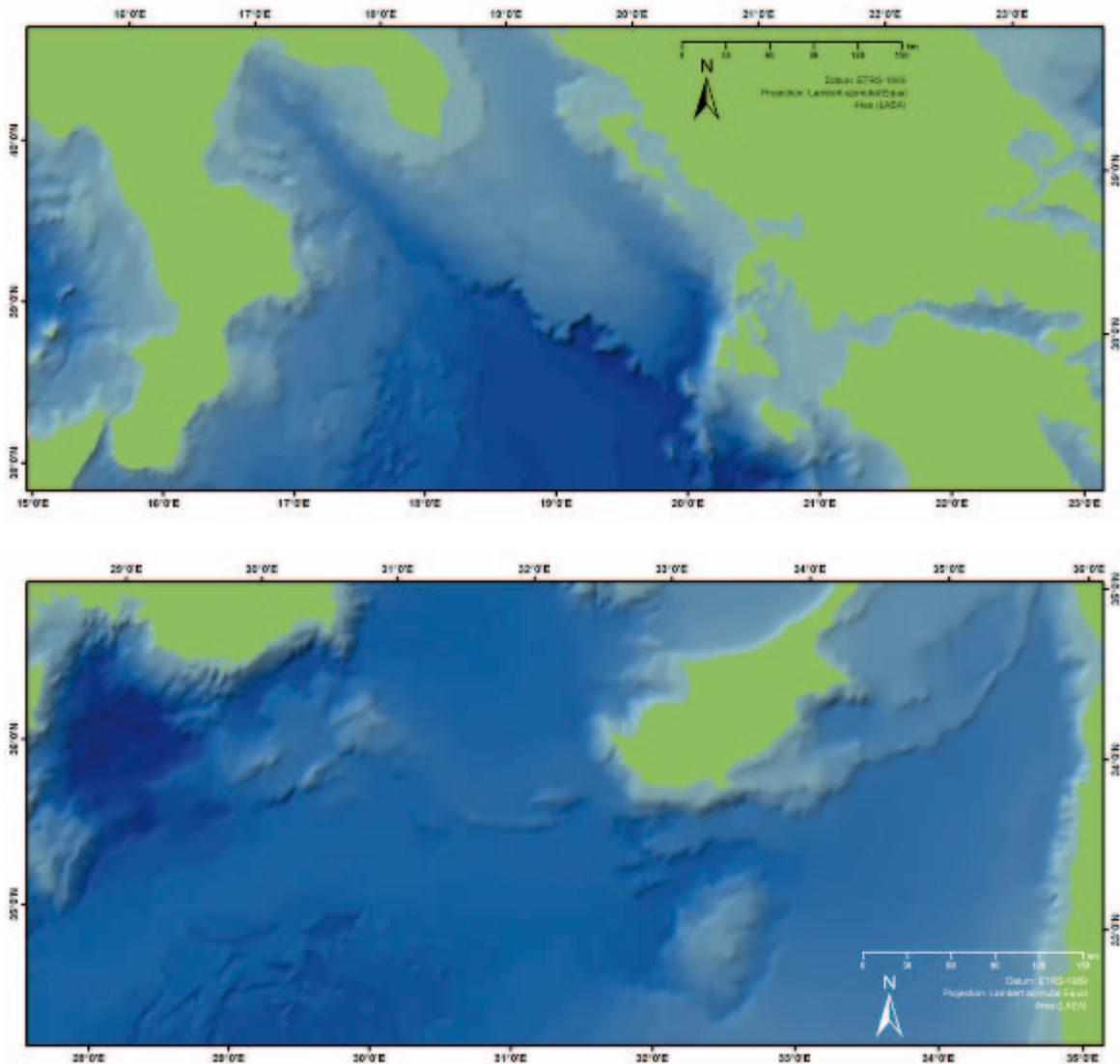


Figure 17. Upper image: a zoom over the area of the Ionian Sea (upper image) In the lower image, the Eratosthenes seamount, one of the most important features of the Eastern Mediterranean seafloor, about 100 km south of western Cyprus.

3.4. Features

Layer(s): Undersea_features.shp. Point. The initial subset of Mediterranean features prepared from the GEBCO Sub-Committee on Undersea Feature Names coordinated database, and the basis for other subsets of data were as seamounts, canyons and seabanks.

The GEBCO Sub-Committee on Undersea Feature Names (SCUFN) maintains and makes available the names of the world undersea features by means a digital gazetteer, whose last version (January 2009) has been used to prepare this geodataset and subsidiaries layers. The SCUFN define the nomenclature used for undersea features, e.g. canyon, plateau, fracture zone, etc., as well as naming guidelines and consider and decide on names which have been submitted to the Sub-Committee of geographical names and the standardisation of undersea feature names. From this list and lon/lat coordinates translated into a .dbf type file (in a database environment) a

first subset of Mediterranean features was prepared and are the basis for this layer and different subsets of data were separated for seamounts, canyons and seabanks (figure 18). The seamounts shapefile (Seamount_like_pnt.shp) considers not only the *sensus stricta* seamounts as defined by the "Guidelines and nomenclature are contained in IHO-IOC Publication B-6 "Standardisation of Undersea Feature Names" but include shoals, hills and knolls. The same procedure was applied to seabanks and canyons.

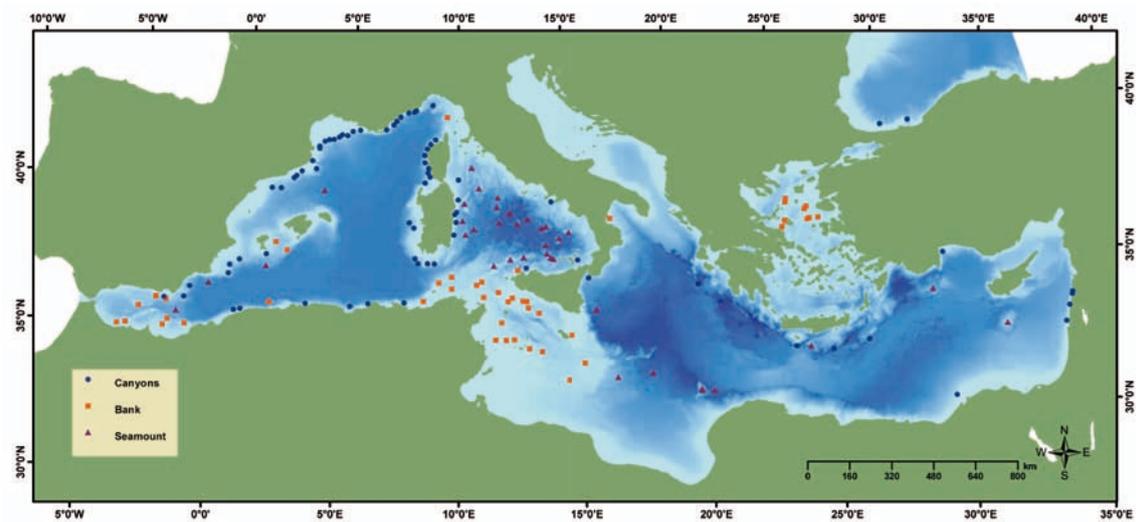


Figure 18. A general layout of the "Undersea_features.shp" layer. This feature is based on the GEBCO Sub-Committee on Undersea Feature Names coordinated database.

From this initial point feature data set, were prepared several subsidiaries as surrounding areas using both the GEBCO bathymetric contours and the Isobaths_cntrs_Med.shp or grids performing a spatial join merging information from the polygon (Seamounts_like_pol.shp) and the 10 km grid for projection "ETRS89-LAEA 52N 10E" in polygon format.

3.4.1. Seamounts

Layer(s):

- Seamount_like_pnt.shp. Point. Seamounts and related features from the GEBCO Sub-Committee on Undersea Feature Names coordinated database.

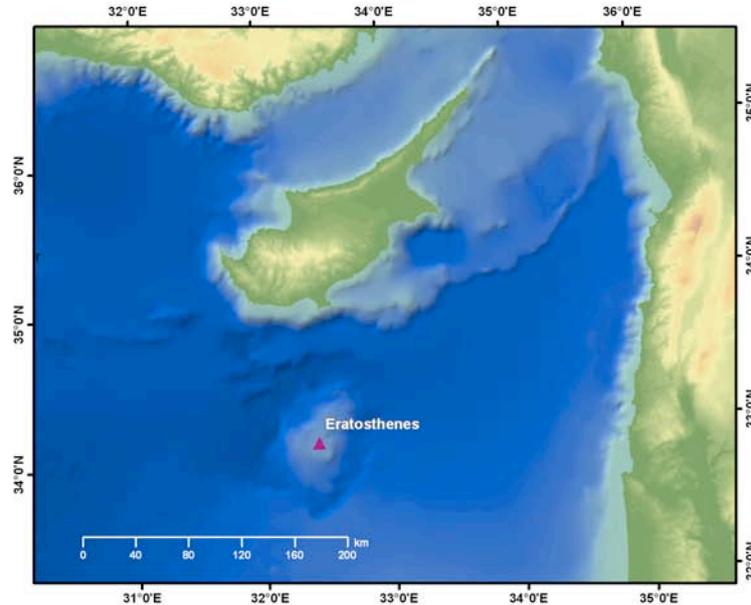


Figure 19. The precise localization of each submerged feature (as, in this example, seamounts) was obtained from the GEBCO Sub-Committee on Undersea Feature Names coordinated database as well as the recognized name (SCUN). Also, the TIN of the eastern Mediterranean Sea reveals this important feature: the Eratosthenes Seamount.

- Seamounts_like_pol.shp. Polygon of the seamount perimeter. From the point shapefile and using the GEBCO bathymetric contours.

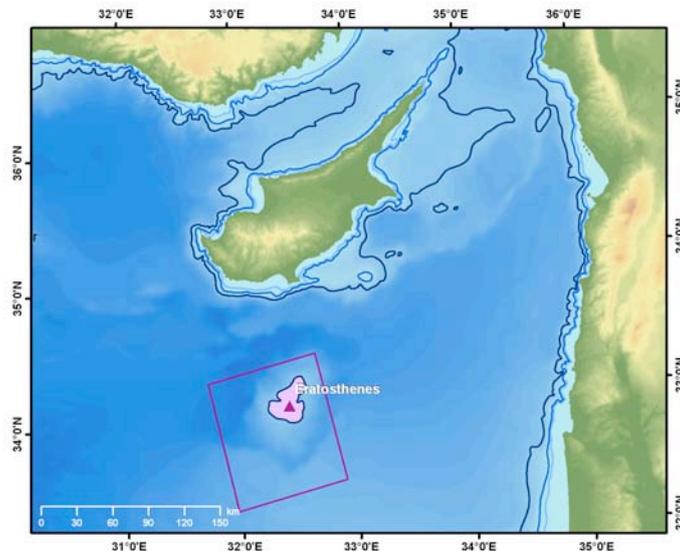


Figure 20. Using the bathymetric contours the 1.000 m depth contour enclosing the peak is selected and converted into a polygon for each of the seamount. A seamount can be defined as steep-sided feature, rising 1.000 m or more from the sea floor and not tall enough to break to the sea surface and turn into islands. In the Eratosthenes example, the FRA boundaries enclosing the protected area are shown (Recommendation GFCM/2006/3).

- Seamounts_like_grid.shp. Polygon cells. Eunis 10 km ETRS_LAEA grid joined with the seabank polygon shapefile.

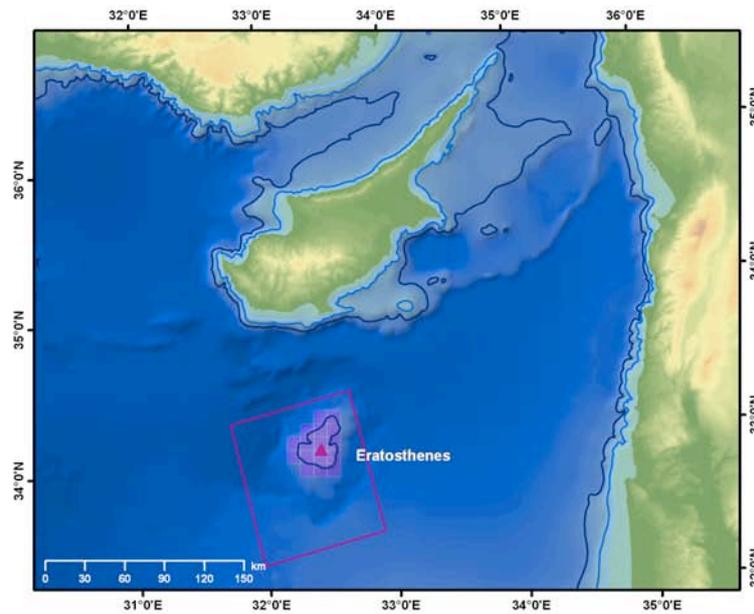


Figure 21. Using the bathymetric contours a seamount is defined by the 1.000 m depth contour enclosing the peak. This contour is converted into a polygon for each of the features. In the Eratosthenes example, the FRA boundaries enclosing the protected area are shown (Recommendation GFCM/2006/3).

3.4.2. Seabanks

Layer(s):

- Seabanks_pnt.shp. Point. Seabanks from the GEBCO Sub-Committee on Undersea Feature Names coordinated database and other consultors.
- Seabanks_pol.shp. Polygon of the seabanks perimeter. From the point shapefile and using the GEBCO bathymetric contours.
- Seabanks_grid.shp. Polygon cells. Eunis 10 km ETRS_LAEA grid joined with the seabank polygon shapefile.

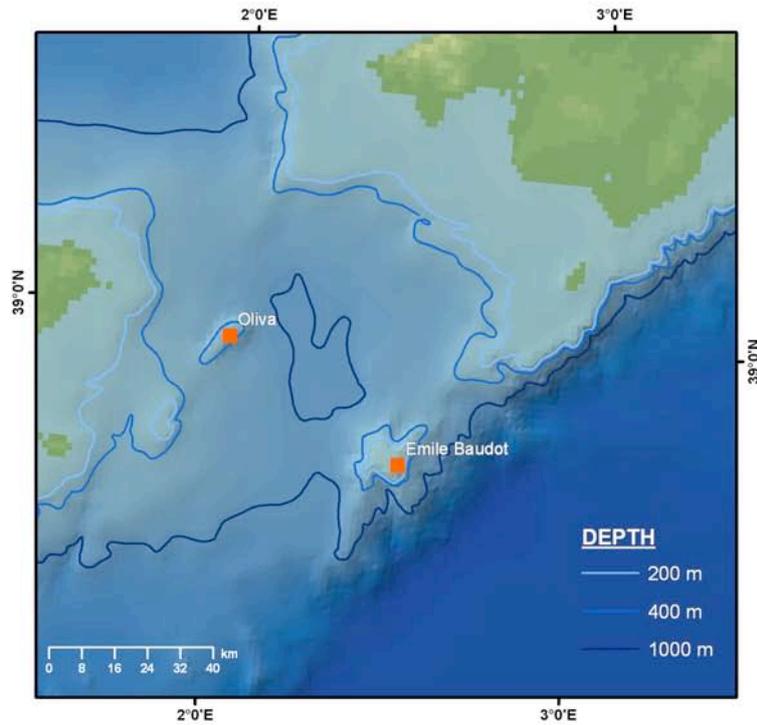


Figure 22. A bank or seabank is an elevation of the sea floor, often with a flattened top, over which the depth of water is relatively shallow, but sufficient for safe surface navigation. The Emile Baudot Bank -this is the IHO-IOC GEBCO Gazetteer of undersea feature names recommended name- has the summit over 100 m depth.

3.4.3. Canyons

Layer(s): Canyons_like_pnt.shp. Point. Canyons and related features localization shapefile from the GEBCO Sub-Committee on Undersea Feature Names coordinated database and other consultants (Fig. 23).

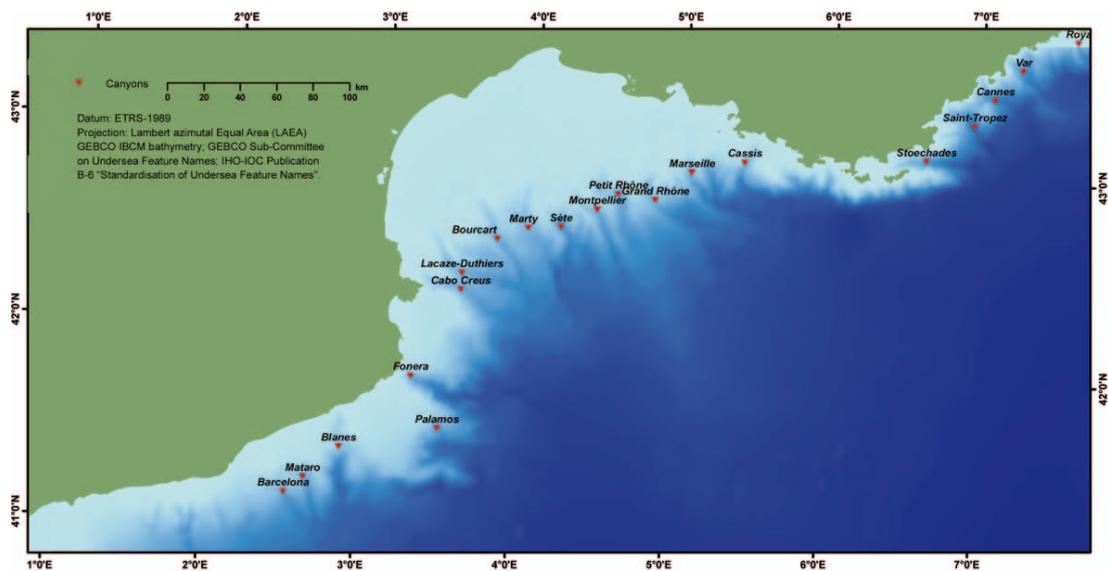
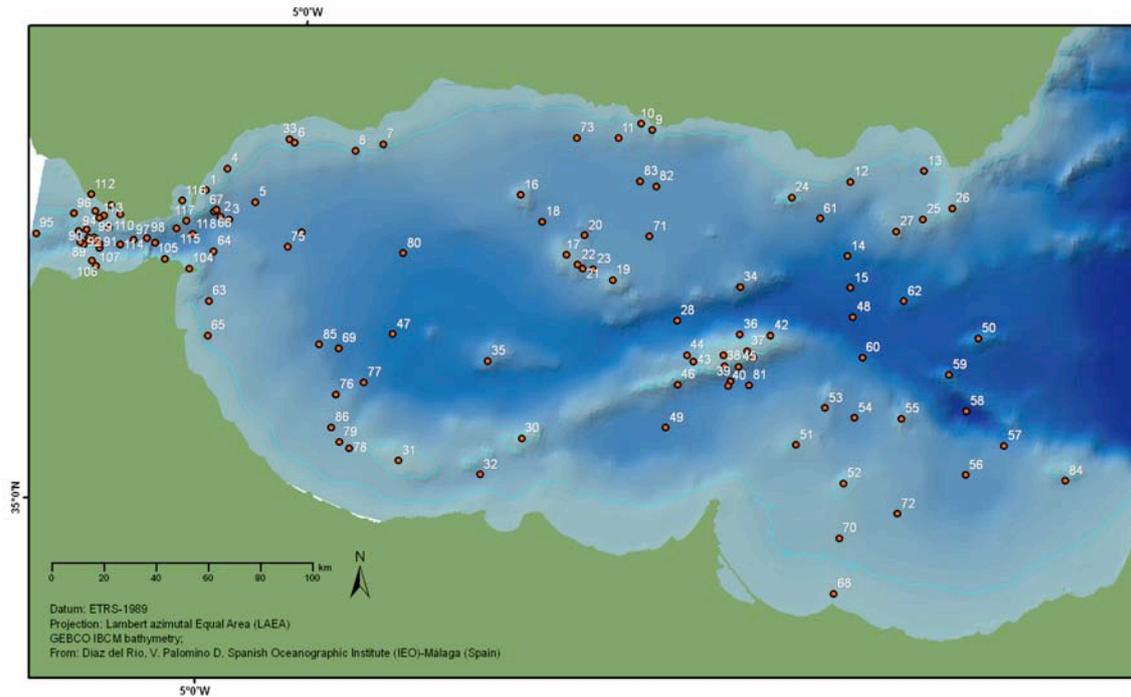


Figure 23. Detail of the Gulf of Lion canyon system.

3.4.4. Alboran

Layer(s): Alboran_Gibraltar_features_IEO.

A total number of 119 features of the Alboran Sea and Straits of Gibraltar were compiled by Díaz del Río V. and Palomino D. from the Spanish Oceanographic Institute (IEO) in Málaga. Extensive bibliographic information was also provided.



Id.	Name	Id.	Name	Id.	Name	Id.	Name
1	La Línea Canyon	31	Xauen Bank	61	Serrata-Carboneras Fault	91	Kmara Crest
2	La Línea Channel	32	Alhucemas Valley	62	Maimonides Seamount	92	Malabata Seamount
3	La Línea Deep Sea Fan	33	Bóvedas Placer	63	Ceuta Canyon	93	Tarifa Ramp
4	Guadiaro Canyon	34	Adra or Averroes Ridge	64	Ceuta Deep Sea Channel	94	Strait High
5	Guadiaro Deep Sea Fan	35	Ibn-Batouta Bank	65	Ceuta Drift	95	Majuan Ridge
6	Guadalmina Canyon	36	Alboran Gullies	66	Gibraltar Spur	96	Bolonia Canyon
7	Fuengirola Canyon	37	Alborán Ridge	67	Gibraltar Gulli	97	Hespérides Seamount
8	Calahonda Canyon	38	Al Borani Canyon	68	Chafarinas Islands	98	Hérculas Seamount
9	Sacratif Canyon	39	Al Borani Channel	69	Alboran Mud Diapir Province	99	Levante Pool (Tarifa Basin)
10	Motril Canyon	40	Al Borani Deep Sea Fan	70	Melilla Carbonate Mound Field	100	Poniente Pool (Tanger Basin)
11	Almuñecar Gullies	41	Piedra Escuela Canyon	71	Motril Marginal Plateau	101	Little Pools
12	Campo de Dalías Gullies System	42	Castor Canyon	72	Moulouya Marginal Plateau	102	Larga Pool
13	Almería Canyon	43	Antares Slide	73	Baraza Slide	103	Gibraltar Basin
14	Almería Channel	44	Antares Scars	74	Perejil Mud Volcano	104	Ceuta Bay

Id.	Name	Id.	Name	Id.	Name	Id.	Name
15	Almería Deep Sea Fan	45	Los Bolos Avalanche	75	Kalinin Mud Volcano	105	Perejil or Coral Island
16	Avempace or Algarrobo Bank	46	Juan de la Cosa Slide	76	Granada Mud Volcano	106	Fénix Banks
17	Herradura Bank or Djibouti Bank	47	West Alboran Basin	77	Marrakech Mud Volcano	107	Portuguesas Banks
18	Herradura Sound	48	East Alboran Basin	78	Dhaka Mud Volcano	108	Los Cabezos Bank
19	Ville Djibouti Bank or El Idrissi Bank	49	South Alboran Basin)	79	Mulhacen Mud Volcano	109	El Puerco Bank
20	Djibouti Spur	50	Al-Mansour High	80	Fuengirola Deep Sea Fan	110	Los Lances Inlet
21	Navarro Slide	51	Tres Forcas Ridge	81	Piedra Escuela Deep Sea Fan	111	Valdevaqueros Inlet
22	Navarro Scars	52	Provençaux Bank	82	Sacratif Deep Sea Fan	112	Bolonia Inlet
23	Calahonda Sound	53	Catifas Bank	83	Motril Deep Sea Fan	113	Luyango Placer
24	Chella Bank	54	Pytheas or Caldeira Basin	84	Alidade Bank	114	Tarifa Narrows
25	Pollux Bank	55	Cabliers Bank	85	Carmen Mud Volcano	115	Acebuche Rill
26	Cabo de Gata Spur	56	Habibas Basin	86	Maya Mud Volcano	116	Algeciras Canyon
27	Avenzoar or Sabinar Banks	57	Habibas Escarpment	87	Tartesos Seamount	117	Algeciras Deep Sea Channel
28	Alborán Sound	58	Yusuf Basin	88	Hispalis Crests	118	Algeciras Deep Sea Fan
29	Alborán Island	59	Yusuf Ridge	89	The Plateau		
30	Tofiño Bank	60	Yusuf Escarpment	90	Seco Seamount		

3.5. SST

SST (Sea Surface Temperature) information was obtained from the MODIS (MODerate Resolution Imaging Spectroradiometer) sensor, available online from the Goddard Earth Sciences, Data and Information Services Centre (GES DISC). Original data are stored in HDF-EOS format files from the six summers and winter periods corresponding from 2003 to 2008. Winter period was considered according to the phenology of the main ecological processes that run from November to April, and summer from May to October. Therefore, each final HDF file was the composite of six months. This summer period of six months covers the breeding season of most tetrapod species. The final combination of the six frames (for winter and summer, see figure 25) was performed using the SST values (degrees Celsius) median values, resulting in two final layers, a winter and a summer average for the last five years. This result is shown in figures 26 and 27; both displays consider the same rank in the legend to facilitate the interpretation. The isotherm contours were obtained from these two final raster images.

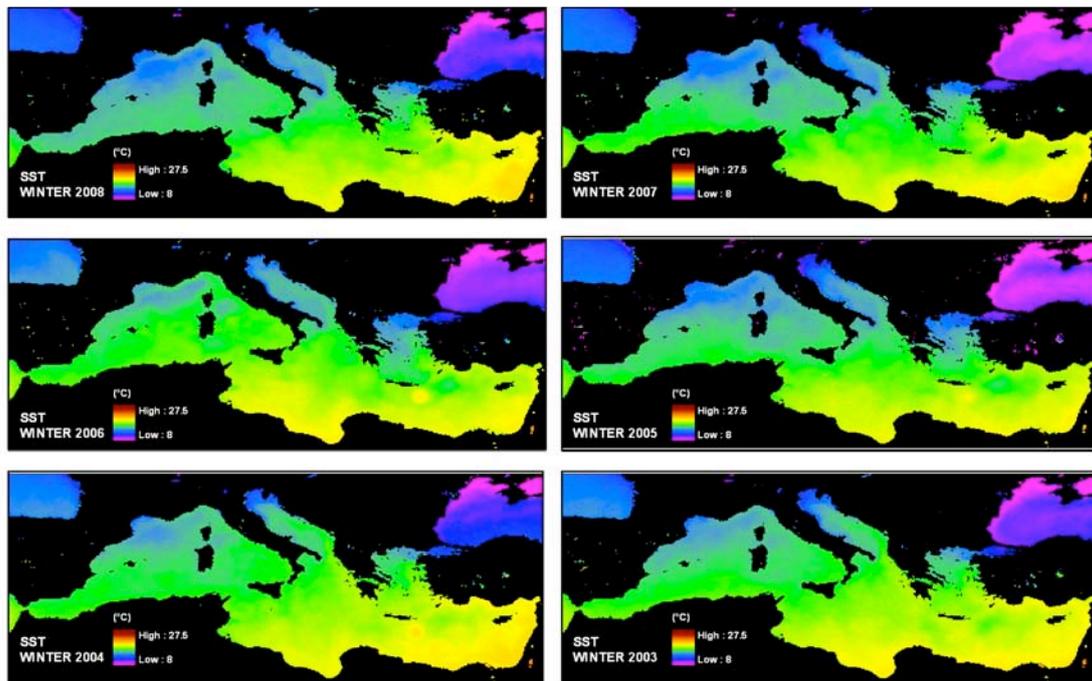


Figure 25. The six frames corresponding to the winters (November to April) from 2003 to 2008.

3.5.1. Winter

Layer(s):

- Isotherm_lines
- sst_win03_08. Raster. Figure 26. Winter (from November to April) sea surface temperature (SST) averaged from 2003 to 2008. Data (°C) from the MODIS (MODERate Resolution Imaging Spectroradiometer) Aqua program. Data provided by (GES DISC).

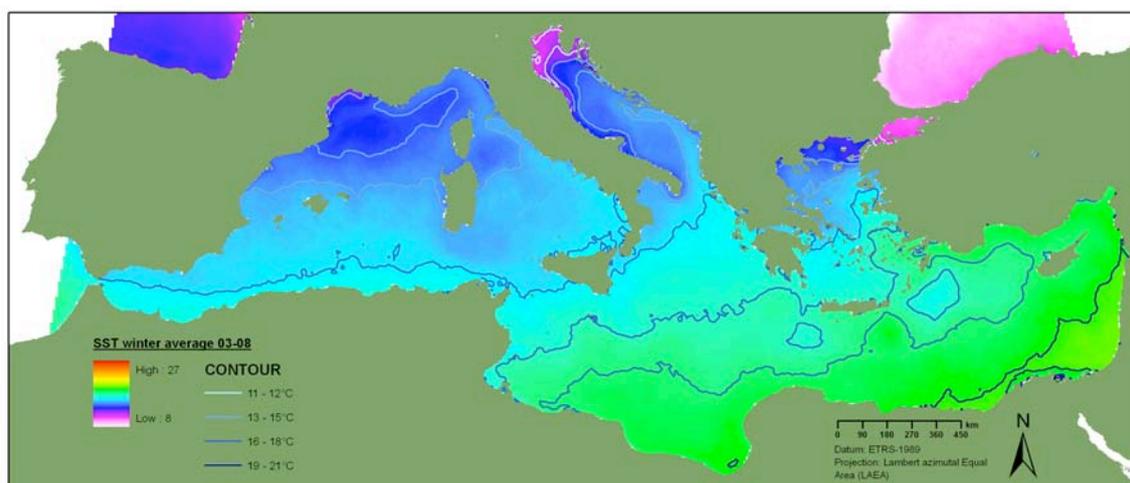


Figure 26. Winter sea surface temperature (SST) average from 2003 to 2008 and isotherms.

3.5.2. Summer

Layer(s):

- sst_sum03_08. Raster. Figure 27. Summer (from May to October) sea surface temperature (SST) averaged from 2003 to 2008.
- Isotherm_lines. Polylines. Isolines from SST_summer03_08_avg data.

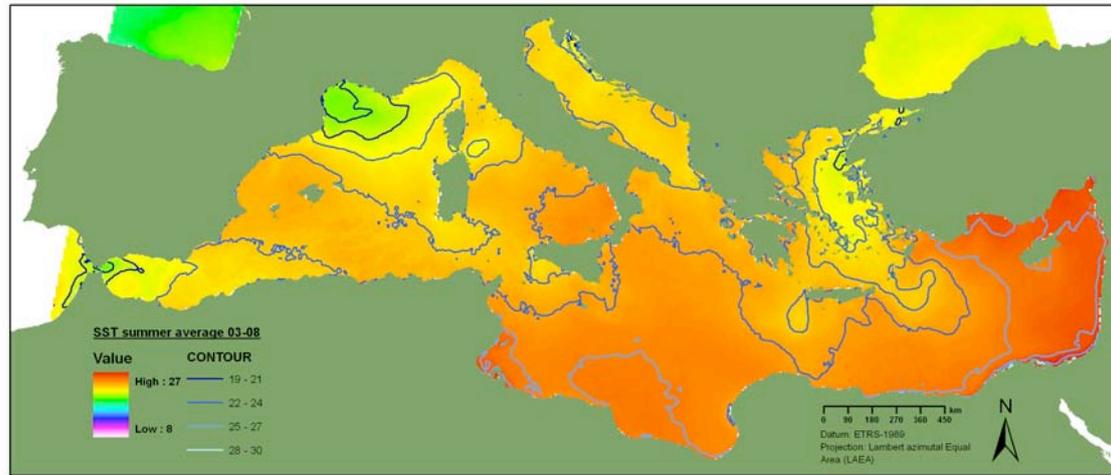


Figure 27. Summer sea surface temperature (SST) average from 2003 to 2008 and isotherms.

3.6. Primary Productivity

The basic Chlorophyll-a concentration data were obtained from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) imagery, available online from the Goddard Earth Sciences, Data and Information Services Center (GES DISC), using the project's own software. Six images in a HDF format corresponding to the six summer periods corresponding from 2003 to 2008 were downloaded from the web server. Summer period was considered from May to October thus each final HDF file was the composite of six months. Each image was a composition of 205 x 523 cells. This six-month period covers the breeding season of most tetrapod species (see figure 28). The same process was repeated for the winter season. All the values beyond the range of SeaWiFS validation (0.05 to 50 mg/m³) were discarded as recommended in the literature. The final combination of these six frames (see figures 29 and 30) was performed using the Chlo-a concentration median values for each cell.

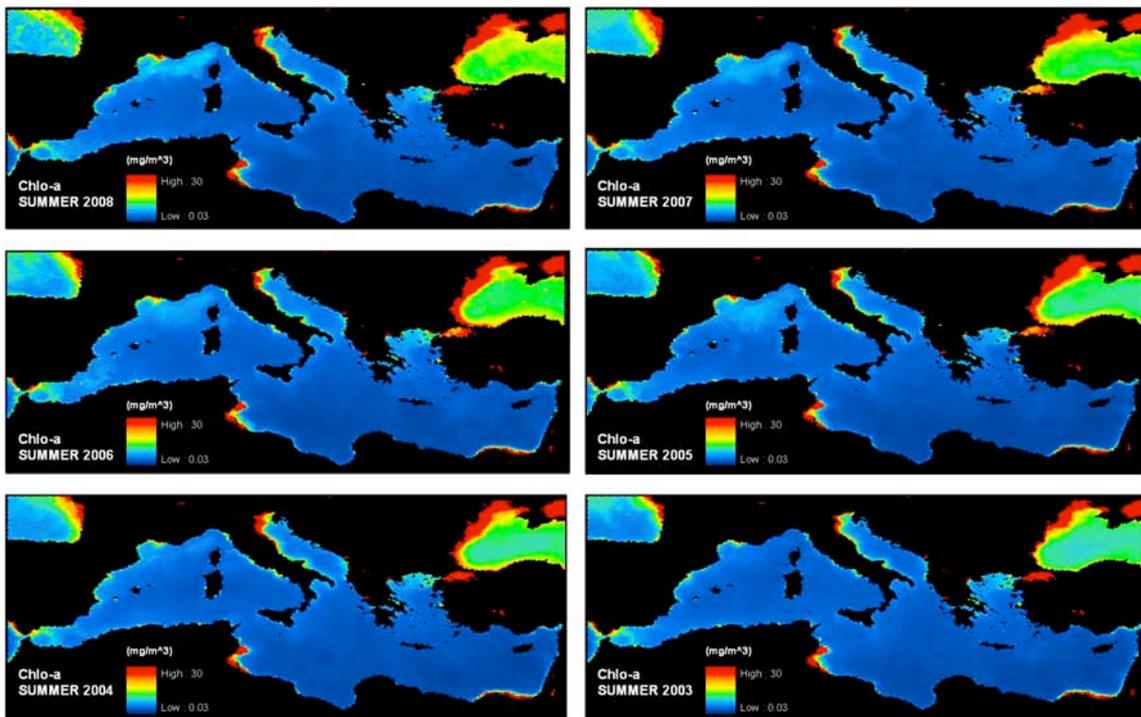


Figure 28. The six frames corresponding to the summers (May to October) from 2003 to 2008 chlorophyll-a concentration. This six-month period covers the breeding season of most tetrapod species in the Mediterranean Basin, and Chlo-a is generally taken as an indirect measure of food availability in the ecosystem. These frames have been enhanced for visualization purposes, trimming extreme values and adopting the same scale for all. Some of the areas seem to be relative reliable in terms of productivity, namely the western Alboran Sea and the Northern Aegean sea and outflow of nutrients from important river systems such as the Rhone-Gulf of Lion, Po and Nil. Also, 2003 reveals itself as different from the rest of the frames in terms of Chlo-a concentration. Much of the reddish areas shouldn't be taken into account for this purpose as probably the high levels of Chlo-a concentrations (very eutrophic areas) are due to anthropic activities. To discern this extreme a further and accurate study should be performed over the raw data.

3.6.1. Winter

Layer(s):

- Chlo_a_isolines. Polylines. Isolines from Chlo-a _winter03_08_avg data.
- Raster. Chlo-a data concentrations (mg/m^3) averaged for the winter of 2003 (from November to April) and averaged for each winter from 2003 to 2008.

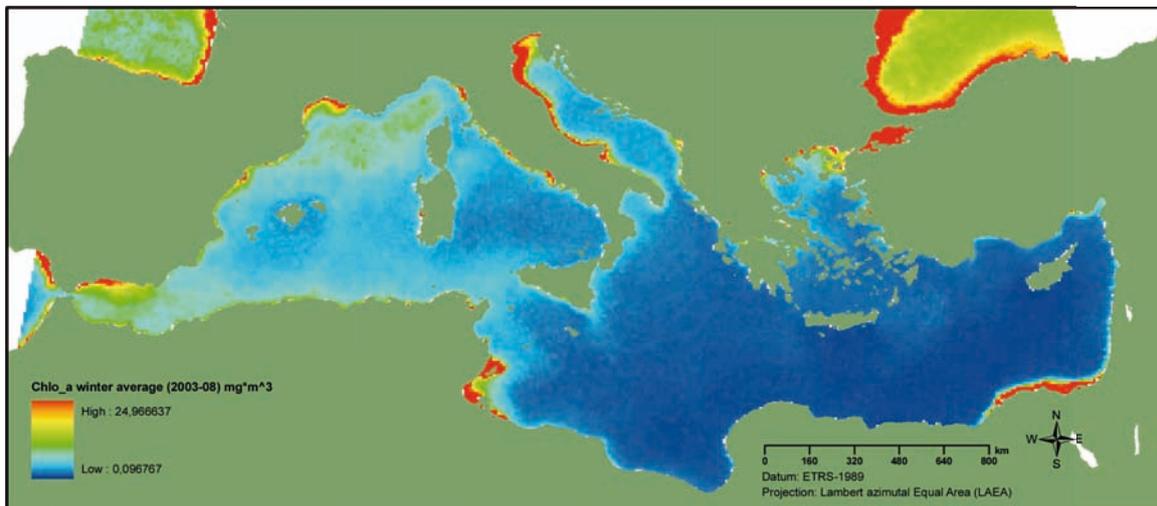


Figure 29. Winter (November to April) Chlorophyll-a concentration from 2003 to 2008.

3.6.2. Summer

Layer(s):

- ISO_chlo_a_summer. Polylines. Isolines from Chlo-a _summer03_08_avg data
- Raster. Chlorophyll-a data concentrations (mg/m³) obtained from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) imagery, and averaged for the summer of 2003 (from May to October) and averaged for each summer from 2003 to 2008.

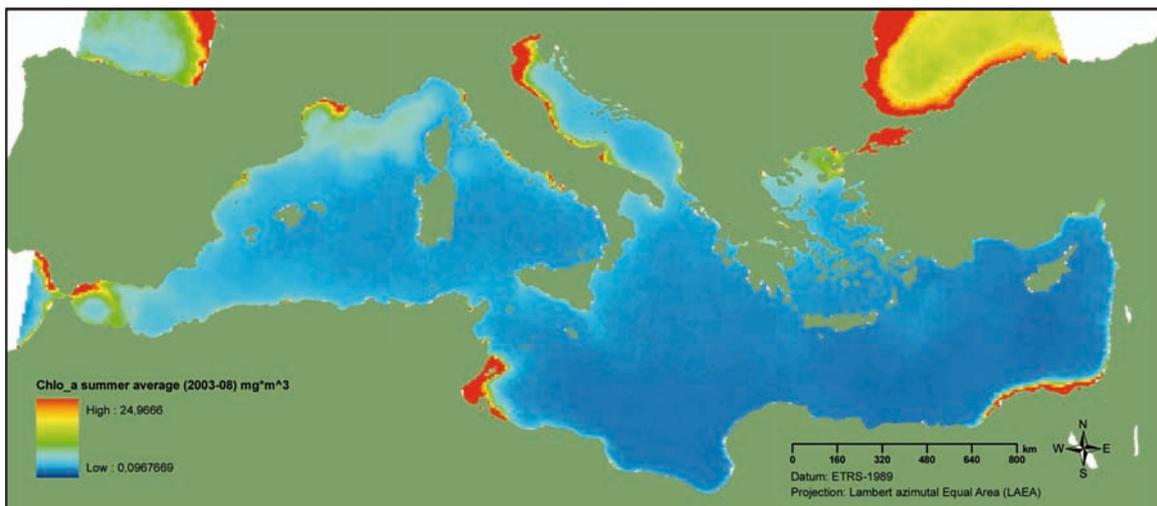


Figure 30. Summer (May to October) Chlorophyll-a concentration from 2003 to 2008.

3.7. Biota

3.7.1. Seabirds

Layer(s): Seabird_grids.

This is the result of compiling and mapping in GIS-format information about the seabird species' known distribution ranges, using different features (dot, polygons or lines) and the EEA reference 10 km grid for projection "ETRS89-LAEA 52N 10E" in polygon format. This layer is the product of the "Georeferenced compilation on bird important areas in open seas" (Requena, S. 2009).

Species' known distribution (both breeding and wintering ranges) was obtained from various sources: published references, consultation to experts, data from censuses at sea and satellite telemetry, plus own data. Only Mediterranean endemic and near-endemic seabird species known to occur regularly in offshore waters were considered for this analysis: *Calonectris diomedea diomedea*, *Puffinus yelkouan*, *Puffinus mauretanicus*, *Hydrobates pelagicus melitensis*, *Phalacrocorax aristotelis desmarestii*, *Larus melanocephalus* and *Larus audouinii*. Each taxon was assigned a one point in the cells where it was known to occur. Additionally, taxa known to currently have a negative population trend in the Mediterranean were assigned an extra point to highlight their higher conservation concern (BirdLife International): *Calonectris diomedea diomedea*, *Puffinus yelkouan* and *Puffinus mauretanicus*.

The information was compiled and mapped in GIS format in a 10x10-km grid. The resulting cells were assigned a numerical value based on the number of species present and their conservation value (endemic and/or in decline) as has been explained. Figure 31 shows the resulting map of adding all the values for each cell. Treatment of the data allowed for graphic representation and for some geographical calculations, as well as for further analysis along with environmental variables

The Mediterranean Sea revealed quite heterogeneous in terms of seabird distribution. Nearly two-thirds (59.32%) of the sum of cells had insignificant presence of priority species (cat. 0-1) and large areas of the ocean had relatively low value with the available information. 'Poor' areas concentrated mostly in the eastern Mediterranean basin, particularly the southern latitudes. Also, in general terms, deep-water areas were poorer in their presence of pelagic birds.

Inversely, priority bird species were present in only about one-third (40.68%) of the total cells and were somewhat dispersed over the areas where they were present; no single cells had a value >7, when the highest possible value was 11.

Priority B areas (ranked from 2 to 4, see figure 30) corresponds with about nearly one-fourth (29.04%) of the sum of cells. These priority B areas are related with the influence of large-scale ocean graphical features (increased productivity, mixing of waters, bathymetric zone) and revealed as a general indicator of areas of conservation interest for seabirds.

Priority A areas are less than 10% (11.64%) of the total sum of cells had the highest importance (cat. 5-7). Priority A areas are found within the limits of priority B zones in all cases. Characteristically, they are found on the continental shelf, around breeding islands or where key oceanographic features (fronts, upwellings) occur.

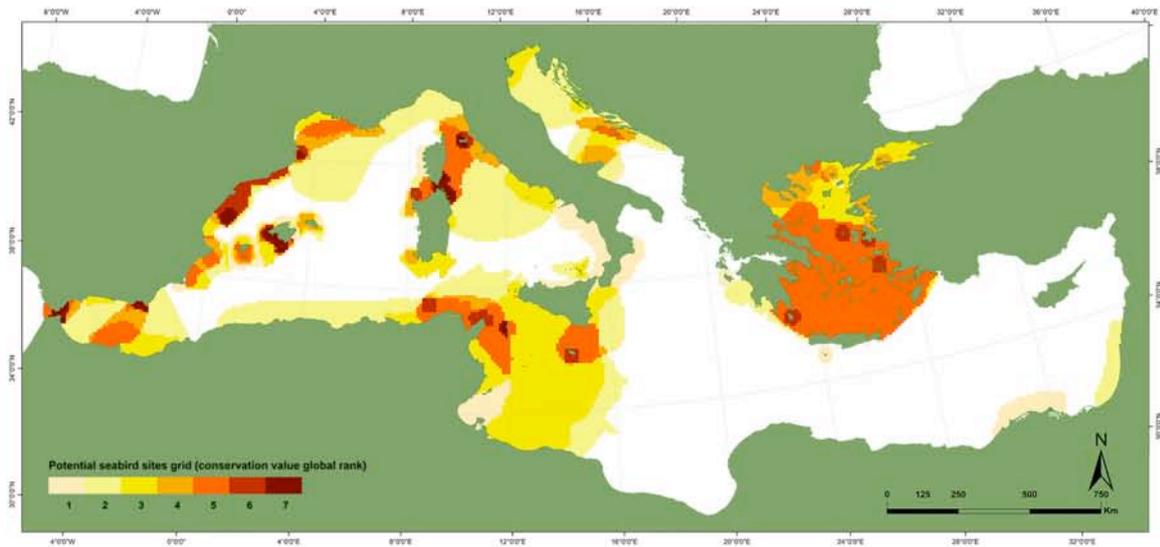


Figure 31. Pelagic distribution of Mediterranean seabirds of conservation concern and potential sites in open seas.

3.8. Marine Areas

3.8.1. Fishery Restricted Areas of GFCM

Layer(s): Fisheries_restric_areasCGFM.shp (figure 32).

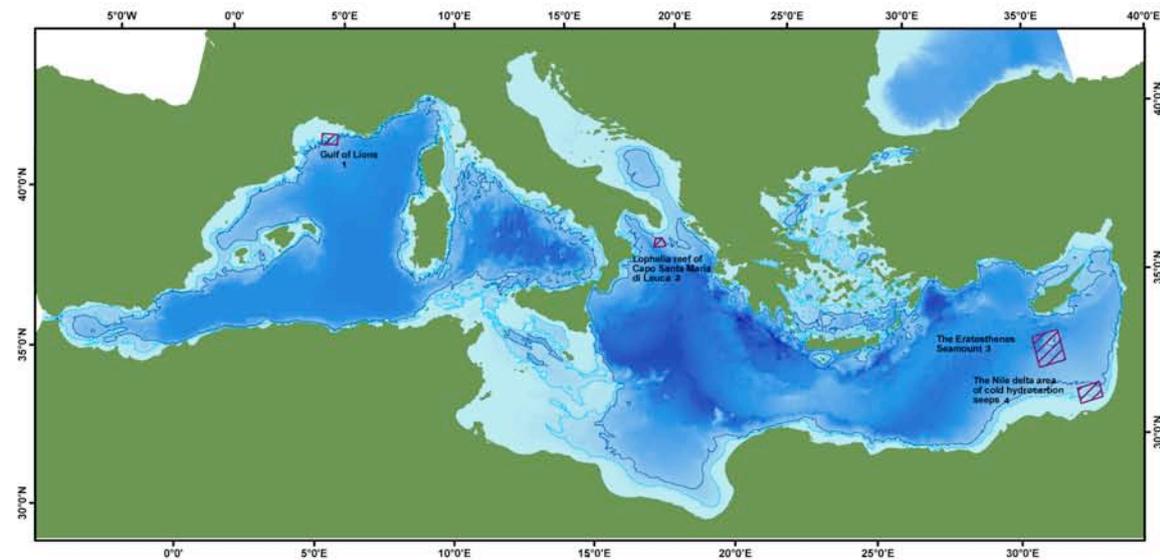


Figure 32. Establishment of a fisheries restricted area to protect spawning aggregations and deep sea sensitive habitats. Area 1, "Recommendation GFCM/33/2009/1", areas 2, 3 and 4, "Recommendation GFCM/2006/3". Also considered "Recommendation GFCM/2005/1 on the management of certain fisheries exploiting demersal and deepwater species and the 1.000 m depth prohibition of towed dredges and trawl nets" and the "review of the management of deep-sea (under 400 m deep) fish stocks (COM(2007) 30 fina)".

3.8.2. Ecologically or Biologically Significant Areas

Layer(s):

- EBSAs_pol.shp; pre_areas_Alboran.shp; Prosp_SPAMI.shp.

These layers are the product of the final report on the identification of potential SPAMIs in Mediterranean areas beyond national jurisdiction” (UNEP-MAP-RAC/SPA 2009). The final feature datasets were prepared using the base of the figures and information available in this final report plus the suggestions of the RAC/SPA technical staff and georeferenced for the purpose of this project.

The site selection process followed by the authors comprised three steps:

1) The identification of potential sites that could include potential SPAMIs. To achieve this goal, a further analysis was made of the previously highlighted priority areas. Data on benthic invertebrates, fish fauna, sharks, birds, marine turtles, pinnipeds, and cetaceans were particularly useful for this process. The authors surveyed key experts in several fields of Mediterranean ecology and marine biodiversity (habitats and species) to highlight especially important areas within each subregion, requesting them to rank criteria according to the extent to which it helped them in their determination. The resulting polygons were overlaid to highlight especially critical areas, 10 EBSAs in all. Figure 33 shows the result of this process for the Alboran Sea EBSA.

2) The identification of the priority regions (EBSAs) (see figure 34) using the refined site selection criteria and described in the table below.

Code	Name	Area (Km2)	Code	Name	Area (Km2)
1	Alboran Sea	39700	6	Adriatic Sea	36127.59
2	Balearic Islands Sea	115871	7	Ionian Sea	105479.13
3	Gulf of Lion area	131753	8	Aegean Sea	20173.93
4	Tyrrhenian Sea	26881	9	Levantine Sea	206139.49
5	Tunisian Plateau	177735	10	Nile Delta area	62367.70

3) A short-list of potential sites in the open seas, including deep sea, which could include potential SPAMIs was prepared and presented as centroids to mark the unspecified area of special interest as possible SPAMI (see figure 35).

- Pre_areas_Alboran.shp

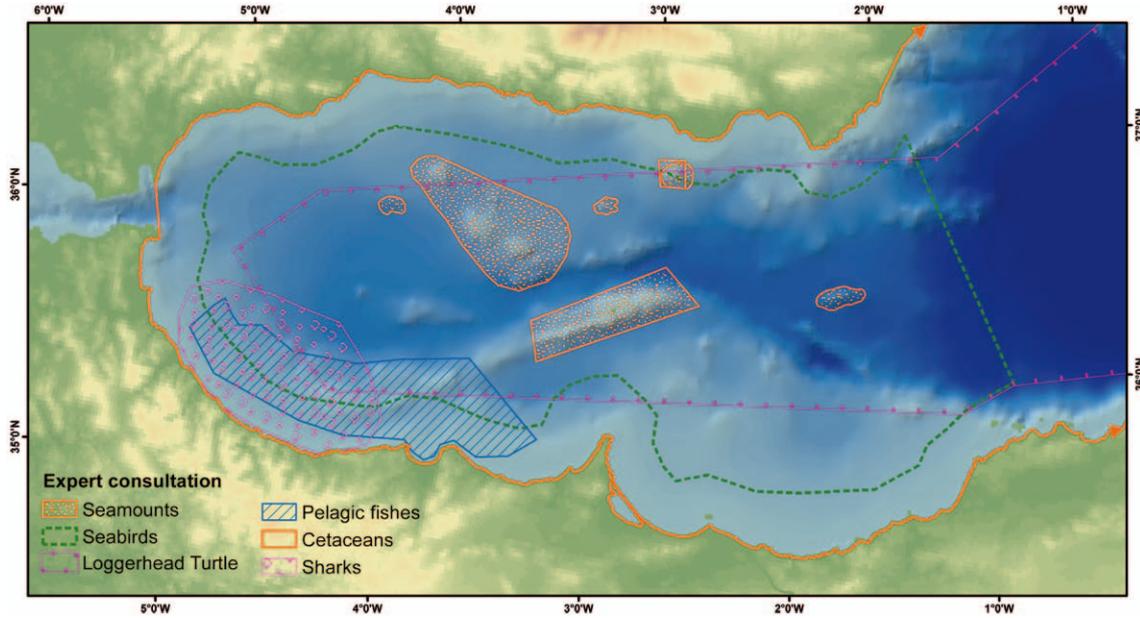


Figure 33. On the basis of an analysis of the information available regarding the presence of important elements of marine biodiversity in the Mediterranean open seas, 10 Mediterranean Ecologically or Biologically Significant Areas (EBSAs) were defined. The information for this example, Alboran Sea, was provided by: V. Agostini (small pelagics), A. Cañadas and R. Sagarminaga (cetaceans), C. Carboneras (seabirds), P. Casale (Loggerhead turtles), F. Serena (sharks) and S. Tudela and X. Pastor (seamounts) (from UNEP-MAP-RAC/SPA 2009).

- EBSAs_pol.shp

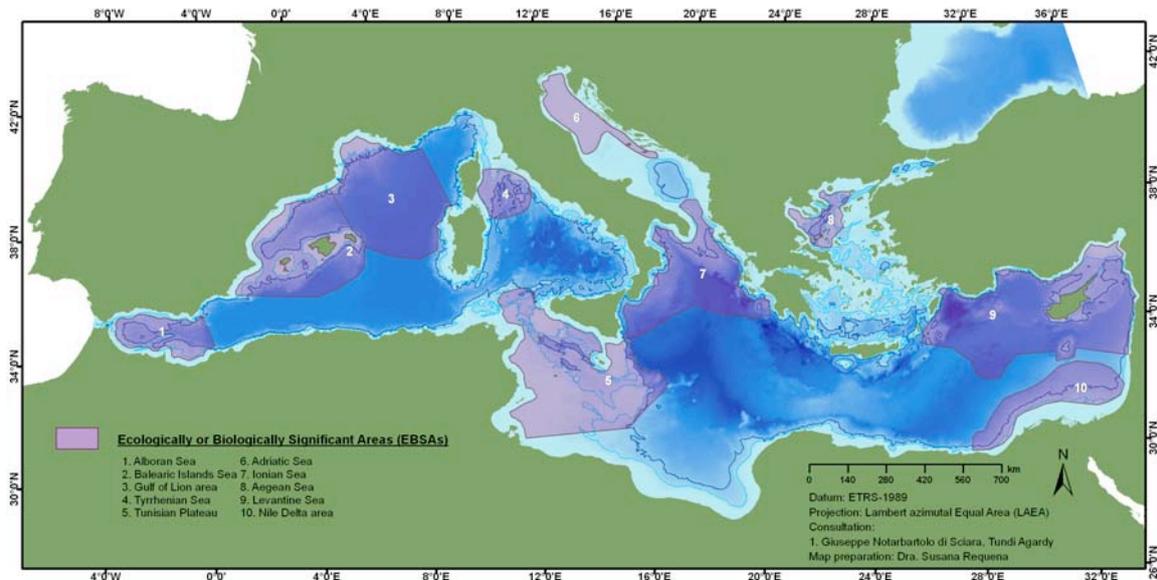


Figure 34. A general view of the 10 EBSAs selected that could include potential SPAMI sites in open seas, including deep seas.

- Prosp_SPAMI.shp

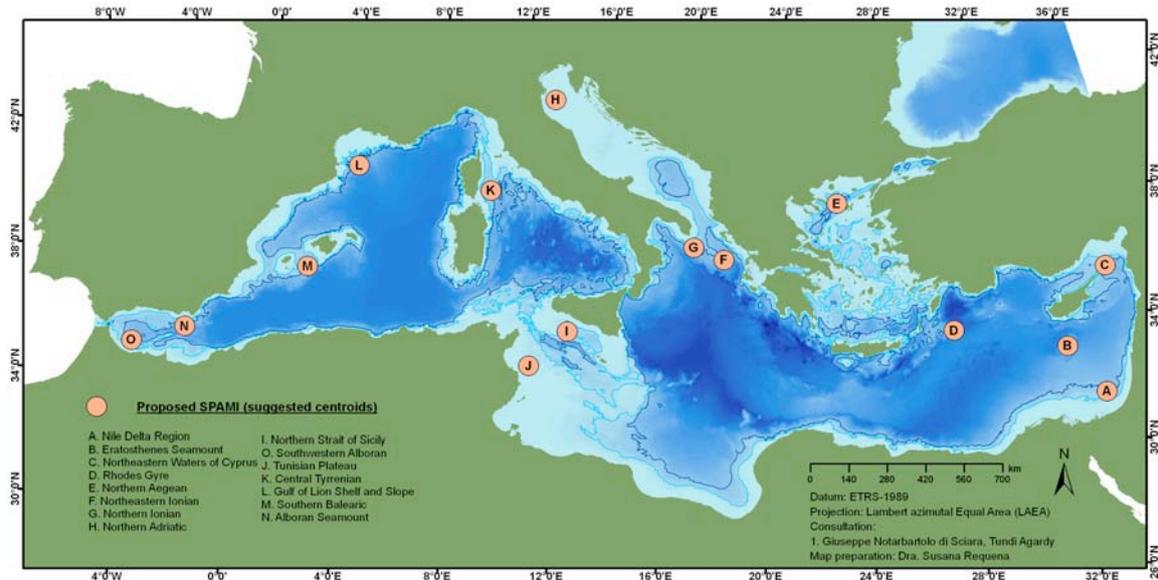


Figure 35. Within the 10 EBSAs a first list of 15 priority sites where selected.

3.8.3. Fisheries management conservation areas

Layer(s): spami_potentialareas_fisheries.shp. Fisheries conservation management and vulnerable ecosystems in the Mediterranean open seas, including deep seas (de Juan, S. and Leonart, J. 2009).

The report proposes priority areas from the interest of fisheries management for the conservation of Mediterranean open seas habitats point of view, as these habitats might be vulnerable to fishing as well as being hotspots of diversity and critical habitats for reproduction and feeding of many species. Thirteen sites are considered as priority areas for conservation in open seas, including deep seas, in order to protect ecosystems from fishing disturbance, including demersal areas (figure 36): Gulf of Lion slope; Alboran Sea Seamounts; Adventure and Malta Banks in the south of Sicily; Cold coral reefs off Cape Santa Maria di Leuca; Jabuka Pit in Central Adriatic, Strymonikos Gulf and Samotraki plateau in the Thracian Sea; Eratosthenes Seamount and Nile Hydrocarbon cold seep in the eastern Mediterranean basin; bottoms beyond 1000m. Potential pelagic areas are the south of the Balearic Islands; Strait of Gibraltar and Alboran Sea; North of Levantine Sea; and Strait of Sicily (from the final report).

The georeferenced information needed for this layer was provided by the authors in a draft .kml layer. This was converted and reprocessed into a GIS format to assign a projection and perform a refining of the contours before the preparation of some geographical information as was requested by the authors and the RAC/SPA staff.

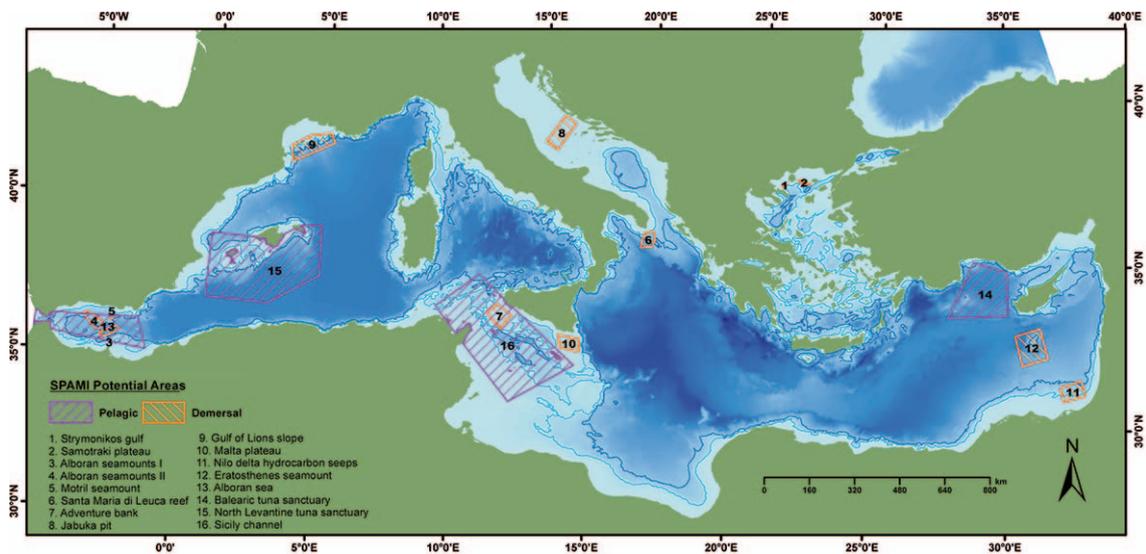


Figure 36. A general layout of the “priority areas regarding fishing impacts in the Mediterranean open seas, including deep seas” layer.

Code	Name	Area (Km2)	Code	Name	Area (Km2)
1	Strymonikos gulf	73,52	9	Gulf of Lions slope	8063,61
2	Samotraki plateau	154,61	10	Malta Plateau	3270,84
3	Alboran seamounts I: bottoms around Alboran Island	1284,90	11	Hydrocarbon seeps	2920,84
4	Alboran seamounts II: seamounts around Djibuti bank	2002,79	12	Eratosthenes seamount	10305,87
5	Motril Seamount	39,54	13	Alboran Sea	29014,83
6	Santa Maria di Leuca reefs	2184,91	14	Balearic Tuna sanctuary	84347,61
7	Adventure Bank	3763,25	15	North levantine Tuna Sanctuary	30053,30
8	Jabuka Pit / Fosa di Pomo	5498,80	16	Sicily channel	97638,79

3.8.4. Genoa Meeting potential areas

Layer(s):

- GENOA_potential_SPAMIs.shp.

In the Second Meeting of the Steering Committee on identification of possible SPAMIs in the Mediterranean areas beyond national jurisdiction (ABNJ) - Genoa, Italy, 18th and 19th November 2009- were exposed the different activities carried out by the consultants for the first-phase project as well as were discussed the draft operational criteria for the identification of Specially Protected Areas of Mediterranean Importance (SPAMIs) in open seas areas, including deep seas, and the short-list of priority areas for conservation that could include potential SPAMIs in open sea areas, including deep seas.

This layer represents the limits of the agreed priority areas for conservation as were settled in this meeting.

- GENOA_potential_SPAMIs_depth.shp.

This layer summarizes the bathymetric information of the agreed priority areas' limits as were settled in the Second Meeting of the Steering Committee on identification of possible SPAMIs in the Mediterranean areas beyond national jurisdiction (ABNJ).

For the basic information, during the meeting, a table on the results of the experts' reports was elaborated containing descriptive elements such as "EBSA, priority area" and the criteria stressing the ecological value of the area. RAC/SPA proposed to the members of the Steering Committee to review in turns the table and each one of the areas (with the aid of the GIS and the Google Earth™ "in live" edition by means of a projector) and to compile the observations that could be raised according to the list of sites presented. The final result of this exercise and subsequent submission of the draft map to all the participants is presented in figure 37.

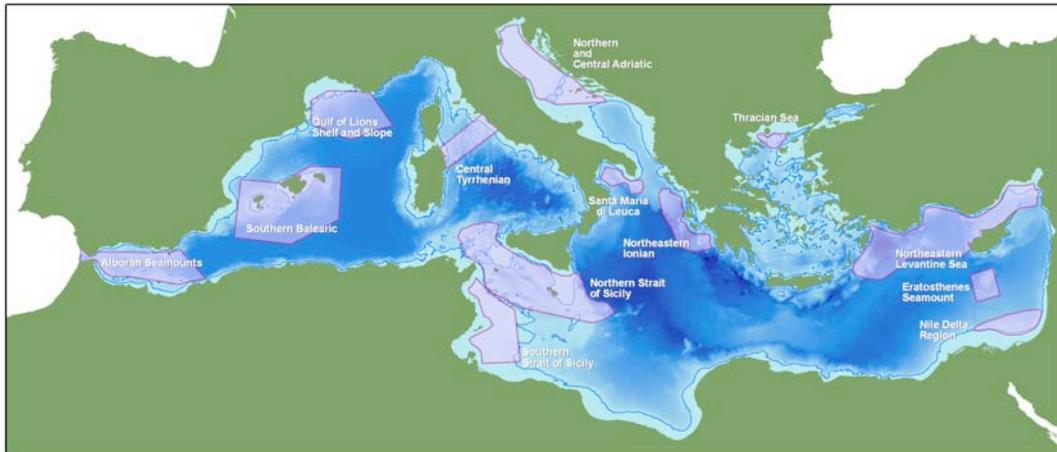


Figure 37. A general layout of the limits of the agreed priority areas for conservation as were settled in Second Meeting of the Steering Committee of the project (Genoa, November 2009). The limits of new potential SPAMIs should be within them.

An initial geographical GIS analysis was performed over the thirteen areas, using the ETRS-LAEA projection layout and grid (see layout 38), which is the EC recommendation for statistical purposes. Their total surface covers about 527.299,18 km² (ca. 20,88% of the Mediterranean Sea). The total area below 1000 m depth covers 279.999,752 km² (11,10% of the Mediterranean Sea), which represents an interesting result in terms of conservation of the open seas, including deep seas. Related with this last figure, another relevant information of legal concern is the area over the continental shelf (up to 200 m deep): 146.732,743 km² (5,81% of the Mediterranean Sea), see figure 38 and the table below.

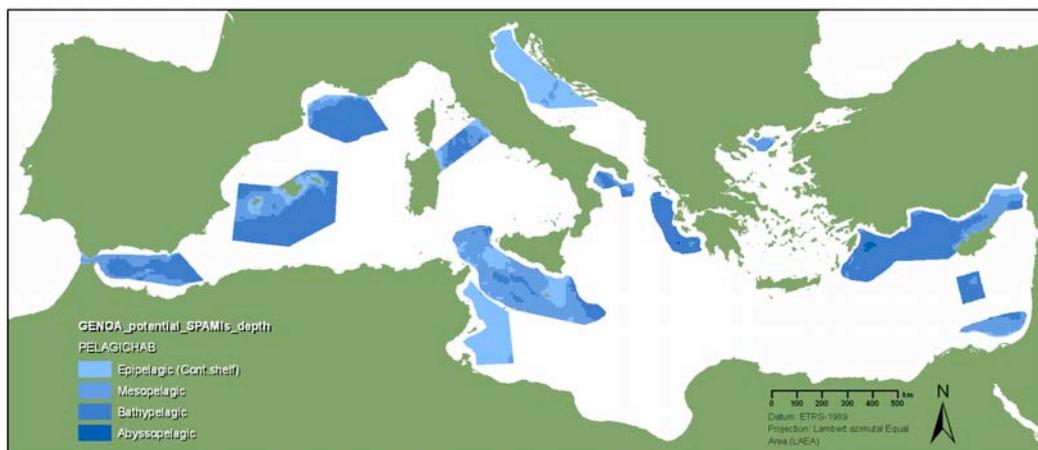


Figure 38. GENOA_potential_SPAMIs_depth.shp. The priority areas for conservation after a spatial join over the "Bathy_Med_mean_grid" shapefile.

The next table compiles some figures about the areas.

Area name		Epipelagic (Cont. shelf)	Bathypelagic	Mesopelagic	Abyssopelagic
Alboran Seamounts	Area (Km2))	1094	22051	18033	
	Depth avg.	-108	-1654	-679	
Central Tyrrhenian	Area (Km2))	3647	8477	7086	
	Depth avg.	-74	-1363	-713	
Eratosthenes Seamount	Area (Km2))		9506	800	
	Depth avg.		-1856	-929	
Gulf of Lions Shelf and Slope	Area (Km2))	2584	35782	5140	
	Depth avg.	-117	-2255	-564	
Nile Delta Region	Area (Km2))	1458	2044	12265	
	Depth avg.	-102	-1092	-626	
Northeastern Ionian	Area (Km2))		19333	717	100
	Depth avg.		-2448	-859	-4043
Northeastern Levantine Sea	Area (Km2))	3485	72275	16455	1200
	Depth avg.	-103	-2259	-634	-4124
Northern and Central Adriatic	Area (Km2))	45049		1881	
	Depth avg.	-82		-215	
Northern Strait of Sicily	Area (Km2))	19155	12118	64732	
	Depth avg.	-125	-1802	-498	
Santa Maria di Leuca	Area (Km2))	47	3896	3763	
	Depth avg.	-147	-1429	-666	
Southern Balearic	Area (Km2))	9447	63301	18691	
	Depth avg.	-78	-2233	-630	
Southern Strait of Sicily	Area (Km2))	36923		702	
	Depth avg.	-78		-210	
Thracian Sea	Area (Km2))	681	179	3286	
	Depth avg.	-129	-1170	-533	

3.9. Digital Elevation Models

Layer(s): medarea_dem. A 1 arc-minute global relief model of land and seafloor for presentation and visualization purposes.

The data for this digital elevation model (DEM) has been provided by the GEODAS (GEOphysical DATA System) database through the GEODAS Grid Translator Design-a-Grid. The dataset used was the ETOPO1. A 1 arc-minute global relief model of land and seafloor that integrates land topography and ocean bathymetry. More details in Amante, C. and B. W. Eakins, ETOPO1 1 Arc-Minute Global Relief Model: Procedures, Data Sources and Analysis, National Geophysical Data Center, NESDIS, NOAA, U.S. Department of Commerce, Boulder, CO, August 2008.



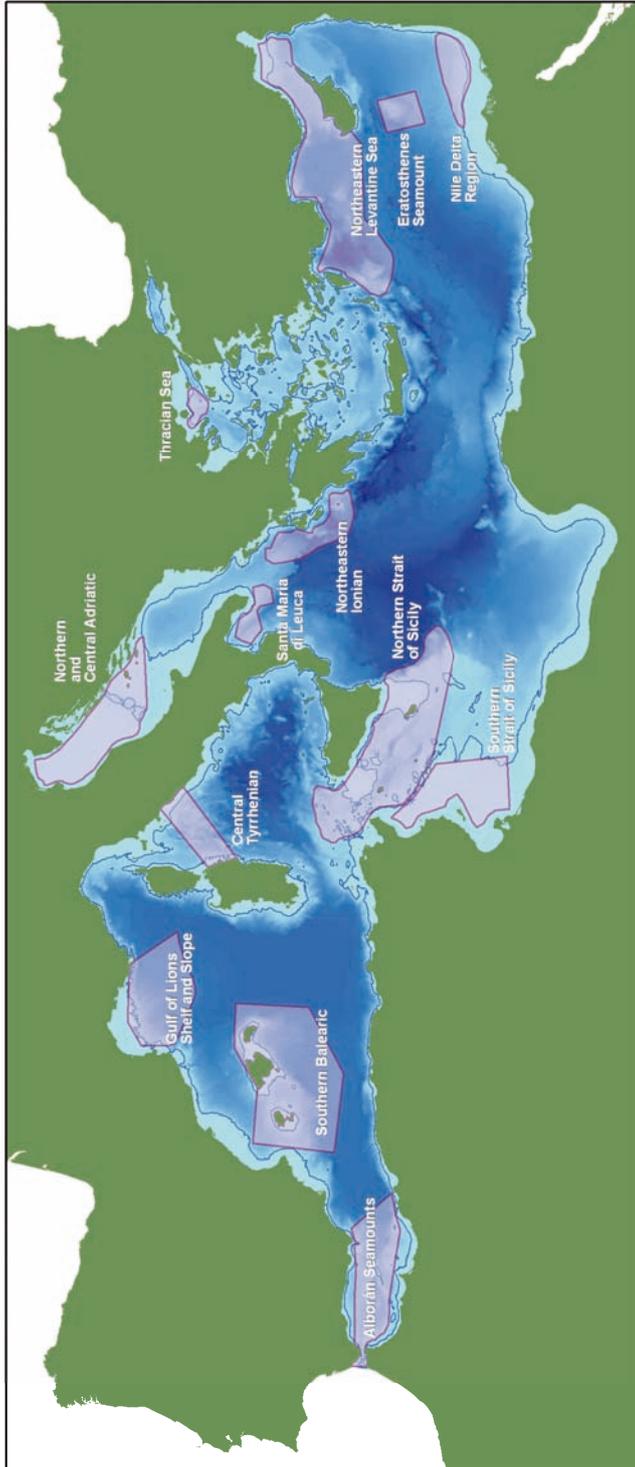
Figure 39. *Medarea_dem. A 1 arc-minute global relief model (digital elevation model) of land and seafloor for presentation and visualization purposes. In this figure, only elevations over 4 m were retained.*

4. Layouts

A graphic set of different layouts of the data collected and prepared in .pdf and .jpg files.

The layouts below show results obtained during the implementation of the project “Identification of possible SPAMIs in the Mediterranean areas beyond national jurisdiction (ABNJ)”. They show different features related to potential areas for the creation of SPAMI in open seas, including deep seas. Such areas embrace zones under different current regimes of jurisdiction existing in the Mediterranean Sea.

Some of them were specially prepared by requirement of the RAC/SPA staff for different purposes as the RAC/SPA participation in the UNEP/CBD *“Expert Workshop on Scientific and Technical Guidance on the use of Biogeographic Classification Systems and Identification of Marine Areas beyond national jurisdiction in need of protection presentation”* (September 2009 - Ottawa, Canada).



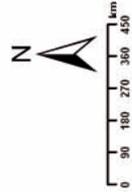
Second Meeting of the Steering Committee on Identification of possible SPAMIs.

SPAMI Potential Areas

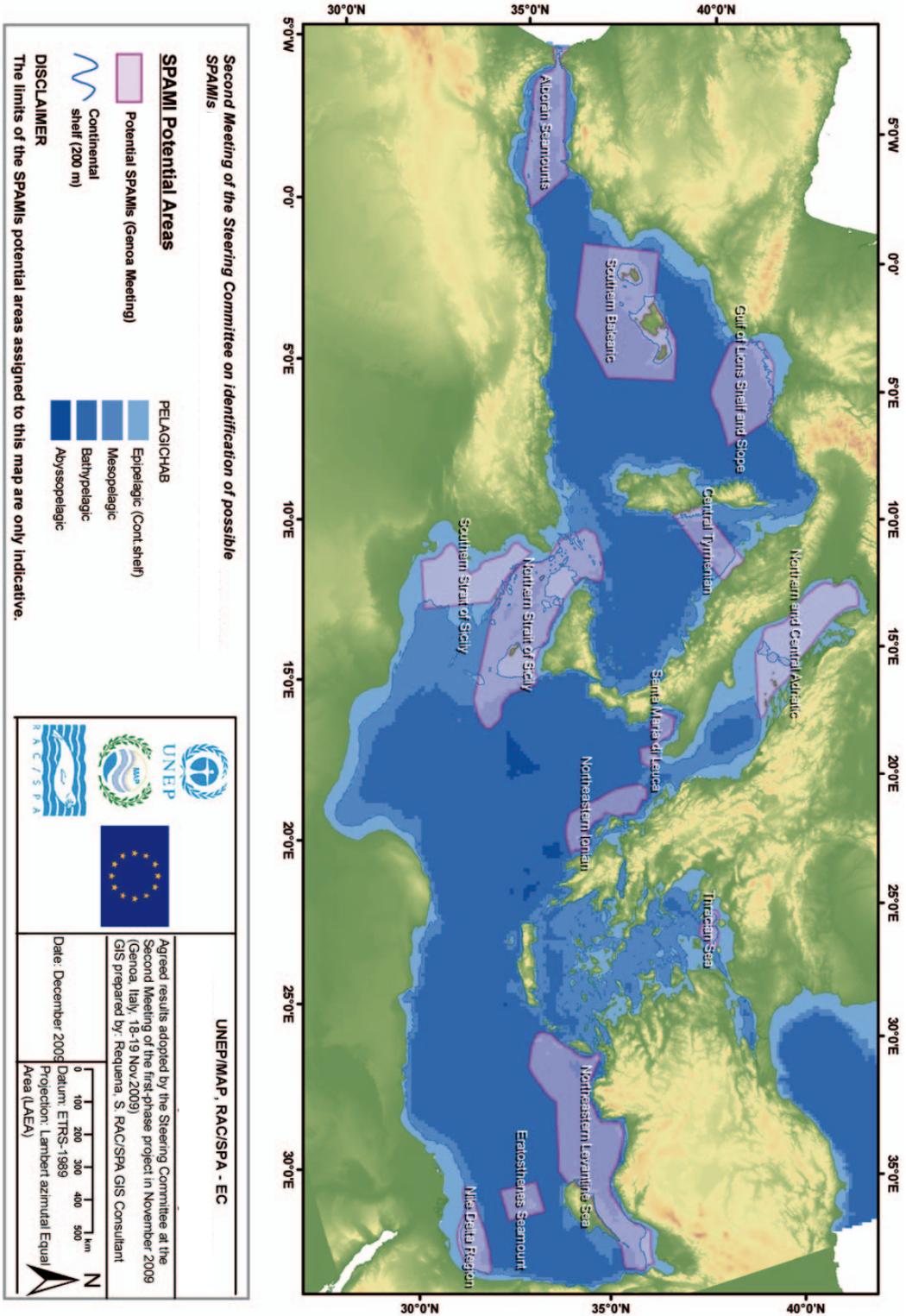
- Potential SPAMIs (Genoa Meeting)
- Continental shelf (200 m)

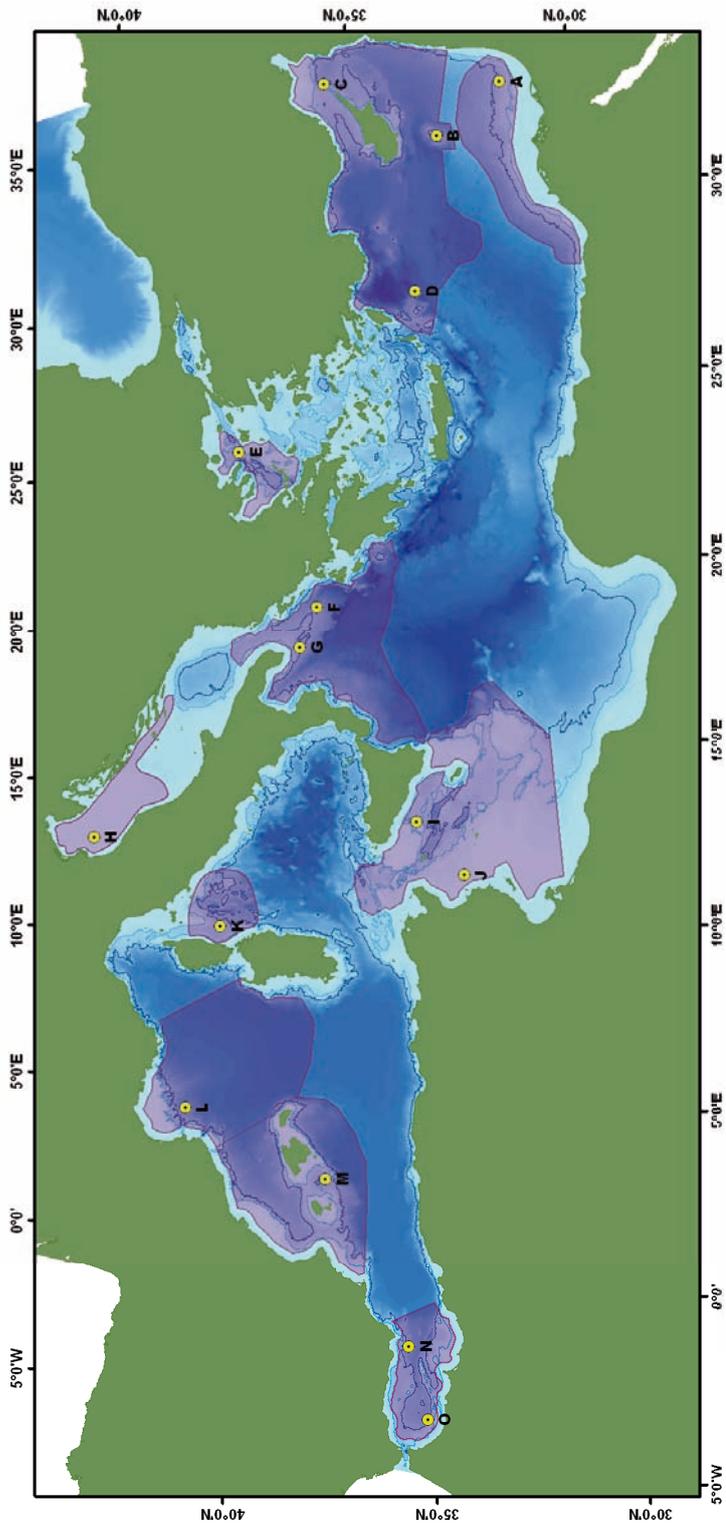
DISCLAIMER

The limits of the SPAMIs potential areas assigned to this map are only indicative.

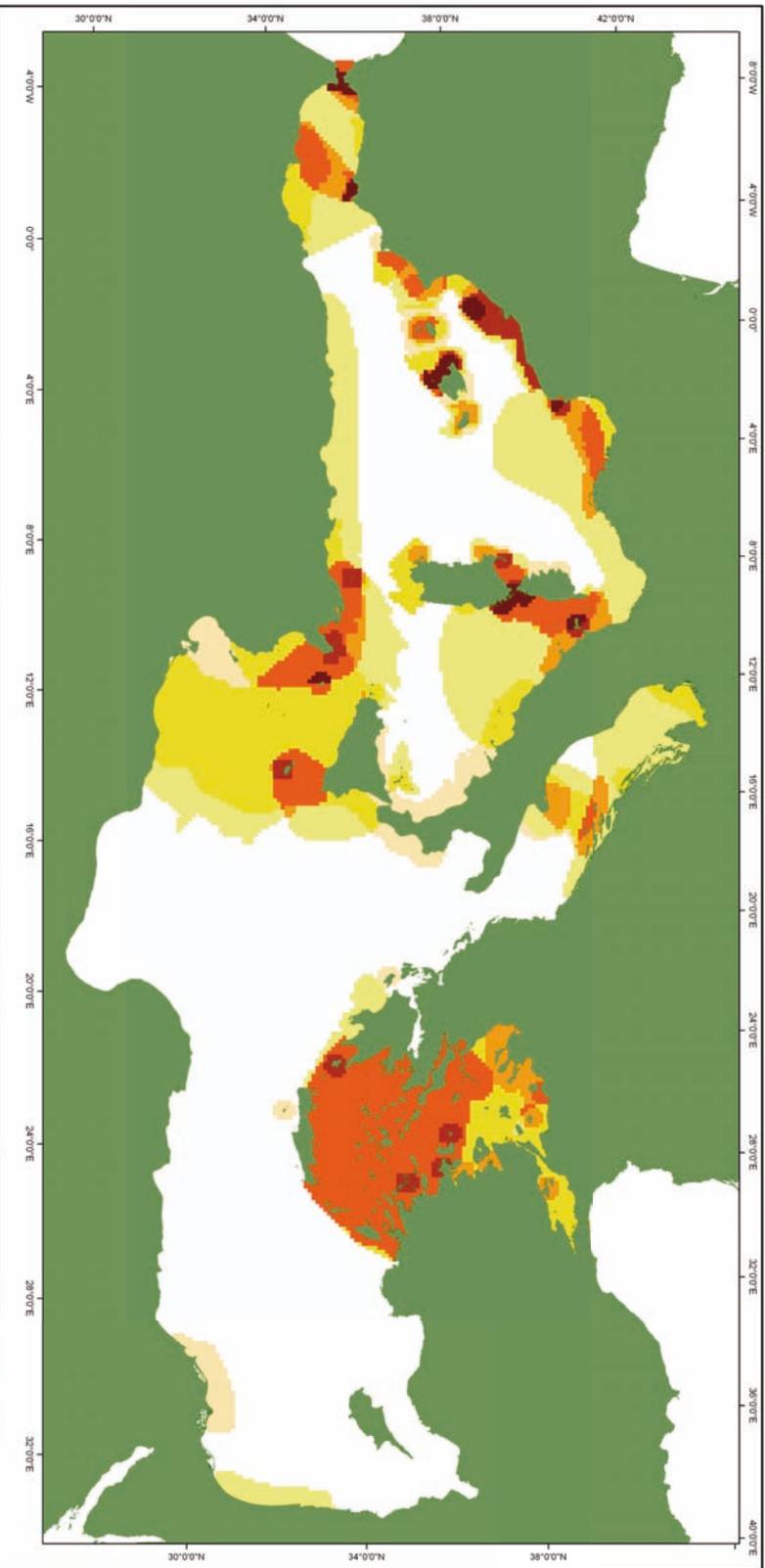


	<p>UNEP/MAP, RAC/SPA - EC</p>
<p>Agreed results adopted by the Steering Committee at the Second Meeting of the first-phase project in November 2009 (Genoa, Italy, 18-19 Nov.2009) GIS prepared by: Requena, S. RAC/SPA GIS Consultant</p>	
Date: December 2009	Datum: ETRS-1989 Projection: Lambert azimuthal Equal Area (LAEA)

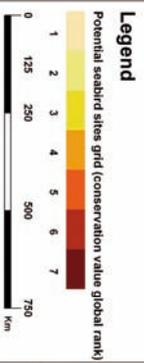




		<p>UNEP/MAP, RAC/SPA - EC</p>	
<p>400 m depth. Review of the management of deep-sea fish stocks EC_COM(2007) 30 final</p>		<p>Date: December 2009</p>	
<p>1.000 m depth prohibition on towed dredges and trawl nets. Recommendation GFCM/2005/1</p>		<p>Area (LAEA) GEBCO IBCM bathymetry; CGFM Recomm. European Commission.</p>	
<p>Ecologically or Biologically Significant Areas (EBSAs)</p>		<p>Datum: ETRS-1989</p>	
<p>Potential SPAMs (suggested centroids)</p>		<p>Projection: Lambert azimuthal Equal Area</p>	
<p>A. Nile Delta Region</p>		<p>North</p>	
<p>B. Eratosthenes Seamount</p>			
<p>C. Northeastern Waters of Cyprus</p>			
<p>D. Rhodes Gyre</p>			
<p>E. Northern Aegean</p>			
<p>F. Northeastern Ionian</p>			
<p>G. Northern Ionian</p>			
<p>H. Northern Adriatic</p>			
<p>I. Northern Strait of Sicily</p>			
<p>O. Southwestern Alboran</p>			
<p>J. Tunisian Plateau</p>			
<p>K. Central Tyrrhenian</p>			
<p>L. Gulf of Lion Shelf and Slope</p>			
<p>M. Southern Balearic</p>			
<p>N. Alboran Seamount</p>			



Pelagic distribution of Mediterranean seabirds of conservation concern. Potential sites in open seas.



UNEP/RACSPA - EC

Source:	Requena, S. 2009. Georeferenced compilation on bird important areas in open seas in the Mediterranean region. Contract N° 23/2009_RACSPA
GIS prepared by:	Requena, S. RACSPA Consultant
Date:	September 2009
Datum:	ETRS-1989
Projection:	Lambert azimuthal Equal Area (LAEA)

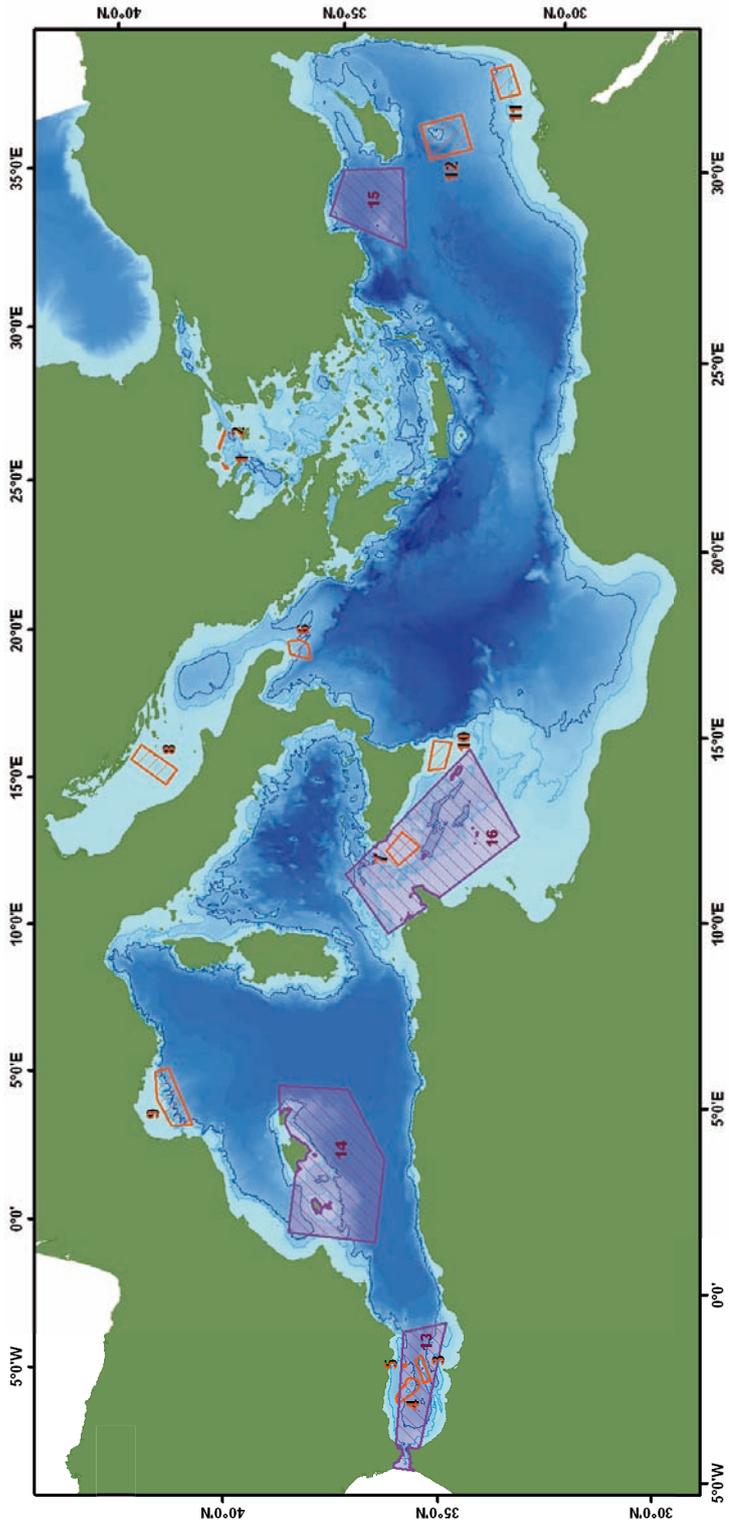
Species' known distribution ranges were obtained from consultation to experts, published references, data from censuses at sea and satellite telemetry & own data (see metadata for details). The information collected was mapped in GIS format. The seabirds' distribution was then overlaid to the ICA reference 10 degree grid (ETRS89 UTM EA 52N 10E) in order to obtain the final result. The map obtained was a 12.347-cell grid covering 1.114.413,075 square kilometers.

Only Mediterranean endemic and near-endemic seabird species known to occur regularly in offshore waters (list A) were considered for this analysis. Each taxon was

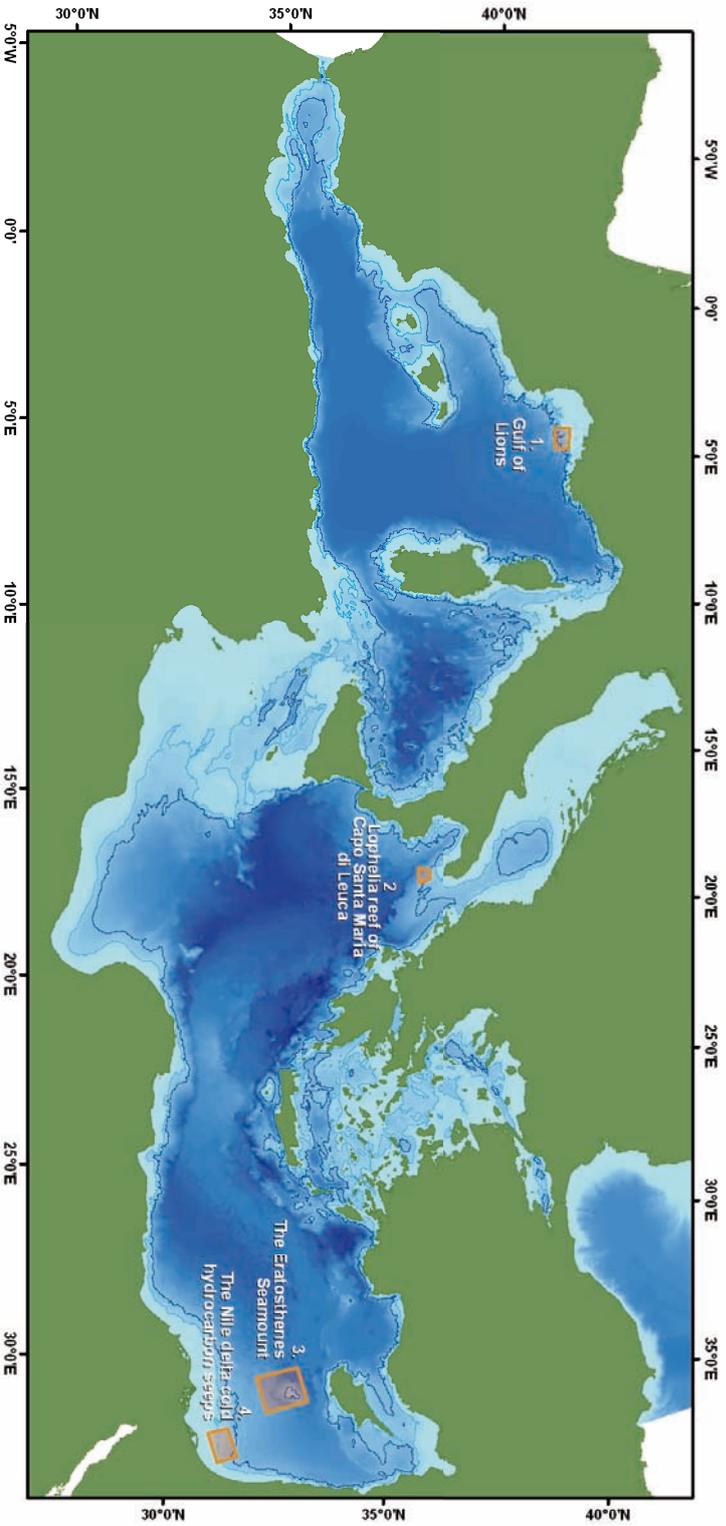
assigned one (1) point in the cells where it was known to occur. Additionally, taxa known to currently have a negative population trend in the Mediterranean (list B) were assigned an extra point to highlight their higher conservation concern. The map shows the result of adding all the values for each cell.

A - List of endemic & near-endemic taxa:
Calonectris diomedea diomedea
Puffinus yelkouan
Puffinus mauretanicus

B - List of taxa additionally in decline (from BirdLife International 2009):
Hydrocaetes pelagicus melitensis
Phalarocoxax aristoteles desmarestii
Larus melanocephalus
Larus audouinii



		UNEP/IMAP, RAC/SPA - EC	
<p>de Juan, S. and Leonart, J. (2009) Fisheries management conservation and step-relief areas in the Mediterranean open seas, including deep seas. Contract N° 34/2009_RAC/SPA. GIS prepared by: Requena, S. RAC/SPA Consultant.</p>			
<p>Date: December 2009</p>		<p>Datum: ETRS-1989</p>	
<p>Projection: Lambert azimuthal Equal Area (LAEA) GEBCO IBCIM Bathymetry; CGFM Recomm. European Commission.</p>			
<p>SPAMI Potential Areas</p>		<p>400 m depth. Review of the management of deep-sea fish stocks EC_COM(2007)30 final</p> <p>1,000 m depth prohibition on towed dredges and trawl nets. Recommendation GFCM/2005/1</p>	
<p> Pelagic</p> <p>1. Strymonikos gulf</p> <p>2. Samotaki plateau</p> <p>3. Alboran seamounts I</p> <p>4. Alboran seamounts II</p> <p>5. Motri seamount</p> <p>6. Santa Maria di Leuca reef</p> <p>7. Adventure bank</p> <p>8. Jabuka pit</p>	<p> Demersal</p> <p>9. Gulf of Lions slope</p> <p>10. Malta plateau</p> <p>11. Milo delta hydrocarbon seeps</p> <p>12. Eretosthene's seamount</p> <p>13. Alboran sea</p> <p>14. Balearic tuna sanctuary</p> <p>15. North Levantine tuna sanctuary</p> <p>16. Sicily channel</p>	<p></p> <p></p>	



Establishment of a fisheries restricted area (FRA) to protect spawning aggregations and deep sea sensitive habitats.

Area 1: Recommendation GFCM/33/2009/1
 Areas 2, 3 and 4: Recommendation GFCM/2009/3

400 m depth. Review of the management of deep-sea fish stocks EC.COM/2007/30 final

1,000 m depth prohibition on towed dredges and trawl nets. Recommendation GFCM/2005/4

Fisheries Restricted Area (FRA)

0 100 200 300 400 500 1 km

UNEP/MAP, RAC/SPA - EC	
Establishment of a fisheries restricted area (FRA) to protect spawning aggregations and deep sea sensitive habitats. CGFM Recommendations GIS prepared by: Requena, S. RAC/SPA Consultant.	
Date: December 2009	Datum: ETRS-1989 Projection: Lambert azimuthal Equal Area (LAEA) / GEBCO IBCOM bathymetry / CGFM Recomm. European Commission.

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