EP

United Nations Environment Programme

UNEP(DEPI)/MED WG.348/Inf.5
7 May 2010

ENGLISH
ORIGINAL: ENGLISH

MEDITERRANEAN ACTION PLAN

Extraordinary Meeting of the Focal Points for SPAs

Istanbul, Turkey, 1st June 2010

REPORT PRESENTING A GEOREFERENCED COMPILATION ON BIRD IMPORTANT AREAS IN THE MEDITERRANEAN OPEN SEAS

UNEP
RAC/SPA - Tunis, 2010

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For citation purposes:
UNEP-MAP-RAC/SPA. 2010. Report presenting a georeferenced compilation on bird important areas in the Mediterranean open seas. By Requena, S. and Carboneras, C. Ed. RAC/SPA, Tunis: 38pp.

Table of contents

1. Introduction

1.1. Mediterranean seabirds in context – the importance of endemic taxa

The Mediterranean region is widely recognised as a source area for endemism at several biological levels, from plants to mammals (Margalef, 1985). Seabirds in particular are a good example of the region's richness and diversity in biota – eight of the nine breeding taxa of exclusively marine birds are either endemic species or subspecies (Zotier, 1999). The Mediterranean is only a small but important sea in the context of global biodiversity; a relatively poor environment with comparatively harsh conditions and that has been in isolation long enough to force the development of new forms of life.

Mediterranean seabirds have a long history of coexistence with man and its consumption of natural resources (Oro, 2003). This is reflected in the current distribution of species and their numbers. The Mediterranean seabird community is exposed to a variety of threats, ranging from industrial fisheries (causing disruptions in the availability of food, and incidental mortality) to pollution (discharge from industry and agriculture, oil, heavy metals) in the open sea (Mínguez et al. 2003). These may cause mortality of adult birds, with important consequences on the demography of long-lived birds, and are additive to land-based factors impacting on the same species: predation (by alien species) on nesting islands, habitat deterioration and destruction, large-scale development, disturbance, etc.

1.2. The Barcelona Convention list of protected species (SPA/BD Protocol)

The Protocol Concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD Protocol) was established in order to safeguard the areas and species that best represent the conservation value of Mediterranean ecosystems. Its Annex II lists the following seabird species of highest conservation concern:

* *Calonectris diomedea diomedea* – Cory's Shearwater (Mediterranean subspecies)

* *Puffinus yelkouan* – Yelkouan Shearwater (endemic)

* *Puffinus mauretanicus* – Balearic Shearwater (endemic)

* *Hydrobates pelagicus melitensis* – European Storm-Petrel (Mediterranean subspecies)

* *Phalacrocorax aristotelis desmarestii* – Mediterranean Shag (Mediterranean subspecies)

* *Larus audouinii* – Audouin's Gull (endemic)

* *Larus melanocephalus* – Mediterranean Gull (near-endemic)

Larus genei – Slender-billed Gull

Sterna albifrons – Little Tern

Sterna bengalensis – Lesser Crested Tern

Sterna caspia – Caspian Tern

Sterna nilotica – Gull-billed Tern

Sterna sandvicensis – Sandwich Tern

Those species marked with an asterisk * have have been highlighted because they:

a) occur further offshore and therefore are more representative of pelagic habitats

b) have higher levels of endemism, at species or subspecies level, and in most cases represent taxa that evolved in isolation in the Mediterranean and do not occur anywhere else in the world

c) have higher levels of threat, according to international standards (IUCN, BirdLife International)

It is those species that should focus our attention, so this work deals mostly with them.

2. Aims

By mapping the (known) distribution range of seabirds in the Mediterranean, it is hoped:

a) to highlight heterogeneities in the marine environment that may reflect differences in habitat quality;

b) to signal areas of high conservation value, particularly as habitat for seabirds;

c) to point at shared responsibilities by two or several States, particularly for the conservation of areas in the open sea.

3. Methodology

3.1. Studied species

Pelagic Mediterranean endemic and near-endemic seabird species known to occur regularly in offshore waters were considered for this analysis. Although they are relatively few, there are several gaps in the knowledge concerning, among other aspects, their distribution at sea for instance feeding areas (they feed mainly from pelagic fish) or migratory movements. More over, their breeding colonies are scattered mainly on small isolated rocky islands and islets and cliffs.

Scientific name	Protected (1)	In decline (2)	Endemic or near-endemic	EC Birds Directive (3)	AEWA (4)
Calonectris diomedea diomedea	●	●	●	●	
Puffinus yelkouan	●	●	●	●	
Puffinus mauretanicus	●	●	●	●	
Hydrobates pelagicus melitensis	●		●	●	
Phalacrocorax aristotelis desmarestii	●	●	●	●	
Larus melanocephalus	●		●		
Larus audouinii	●		●	●	●

(1). Barcelona Convention. Protocol concerning specially protected areas and biological diversity in the Mediterranean. Annex II: List of Endangered or Threatened Species.

IUCN. IUCN Red List of Threatened Species. IUCN. 2008.

(2). BirdLife International. (2009). Species factsheets. http://www.birdlife.org

UNEP-MAP-RAC/SPA. (2006). Proceedings of the first symposium on the Mediterranean Action Plan for the conservation of marine and coastal birds. Vilanova i la Geltrú, Spain.

(3). EC Birds Directive. Council Directive 79/409/EEC on the conservation of wild birds. Annex I. Species subject of special conservation measures concerning their habitat in order to ensure their survival and reproduction in their area of distribution.

(4). AEWA. Agreement on the Conservation of African-Eurasian Migratory Waterbirds. Annex 2: Waterbird species to which the Agreement applies.

Species' known distribution (both breeding and wintering areas) and ranges were obtained from a wide variety of internationally recognized sources: consultation to experts, published references, data from censuses at sea and satellite telemetry & own data (see bibliography).

3.2. Information and environmental variables processing

The information collected was provided in a broad variety of formats: published maps in .jpg pictures, raw geographical localizations tables, Google KML files or previous works in GIS formats but in different cartographical projections or unknown. The first step was to map all this information in GIS-format using an appropriate feature (dot, polygons or lines) depending on the nature of data. For this process, Quantum Gis (www.qgis.org), an open–source GIS program distributed under GNU public license, was chosen. Among other interesting features, it has a great processing

potential as well as “ready-to-use” filters to import and export among different GIS or peripheral files including Esri shapefiles, Google kml or HDF[1] raster images. Also other tools of 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” (Duester and Ziegler, 2009), 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).

Following the INSPIRE Directive (Infrastructure for spatial information in Europe (http://inspire.jrc.ec.europa.eu/) and the European Environmental Agency guidelines (EEA, 2008) where possible, the European Terrestrial Reference System 1989 (ETRS89) has been used, as the geodetic datum for pan-European spatial data collection, storage and analysis. Also, following the European Commission recommendation the Lambert Azimuthal Equal Area (ETRS89-LAEA) projection was selected due to its suitability for storing raster data, for statistical analysis and for map display purposes. More over, 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 (EEA, 2008).

Another recommended method to optimise data for visualisation, analyses and to fine-tune the spatial indexes in the data repository is to resort to using spatial grids. This procedure not only ensures that each feature enclosed in the cell will be processed for statistical purposes once 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 grids omit direct spatial reference and average the qualitative properties of the different objects collected from the variety of information sources used. Grids are, thus, powerful tools for harmonisation and reduction of the complexity of spatial datasets (EEA, 2008). In the last years, many of the projects pursuing the identification of marine protected areas (MPA) in open seas have chosen this methodological approach as the EU “Empafish: Marine protected areas as tools for fisheries”, the “MESH: mapping European seabed habitats” (http://www.searchmesh.net) or the JNCC “Identification of nationally important marine areas in the Irish Sea”, among others.

Working with an equal area grid was preferred for our objectives. This 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 choice. 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 mapped feature and its geographical “uncertainty”. In this way, only relevant details are captured, and “repeated” values are minimized. After testing some different resolutions and considering the disparity of data resolution, a 10 x 10 km square cell (thus 100 km^2) was the adopted solution.

[1] Hierarchical Data Format, refers to some file formats and libraries designed to store and organize large amounts of numerical data. Originally developed at the NCSA, it is currently supported by the non-profit HDF Group.

Some other relevant information used to determine limits were:

- **Bathymetric information** was obtained from the GEBCO One Minute Grid, 2008 updated version, downloaded from the British Oceanographic Data Centre (BODC) website www.bodc.ac.uk/data/online_delivery/gebco/ and processed using their own software.

- **Shoreline.** The NOAA National Geophysical Data Center (NGDC) provides a GSHHS-shoreline (a Global Self-consistent, Hierarchical, High-resolution Shoreline Database) with an optimal resolution for our objectives, as it features all the small islands where breeding colonies are known. These data are in the public domain, have undergone extensive processing and are free of internal inconsistencies such as erratic points and crossing segments. This shoreline is recommended to be used for further data selection or to study the statistical characteristics of shorelines and land-masses.

- **Sea surface temperature (SST)** from the MODIS (MODerate Resolution Imaging spectroradiometer), available online from the Goddard Earth Sciences, Data and Information Services Centre (GES DISC). Original data are stored in HDF-EOS format files format from the six summer periods corresponding from 2003 to 2008 and downloadable from the web server. Twelve images in a HDF format corresponding to the six winter periods and the six summer periods corresponding from 2003 to 2008 where downloaded from the web server. Winter period was considered from November to April and summer from May to October, thus each final HDF file was the composite of six months. This summer period of six months covers the breeding season of most seabird species. Each image, originally in a Cylindrical Equidistant projection, had 205 x 523 cells. The final combination of these six frames was performed using the SST values (degrees Celsius) median values (Ramirez et al. 2008) for each cell.

- **Sea productivity** in terms of Chlorophyll-*a* (Chlo-*a*) concentration appears repeatedly as one of the most relevant variables to predict seabird foraging grounds (Navarro & González-Solís, 2009; Ramirez *et al.* 2008, Baduini & Hyrenbach, 2003). 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 Centre (GES DISC) (http://oceancolor.gsfc.nasa.gov /SeaWiFS using the project's software. As well as for SST, twelve images in a HDF format where downloaded from the web server. All the values beyond the SeaWiFS validation range (0.05 to 50 mg/m^3) were discarded as recommended in the reviewed literature. The final combination of these six frames was performed using the Chlo-*a* concentration median values for each cell.

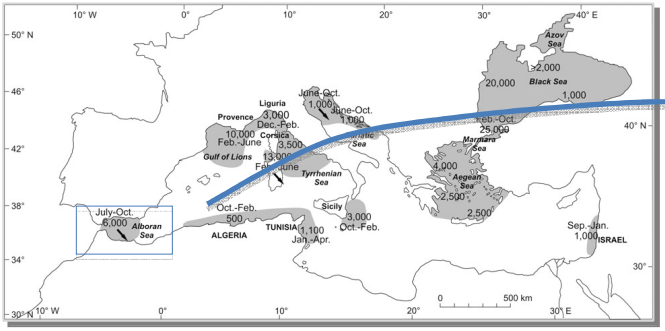
- **Seamount proximity.** Proximity to seamounts has revealed a predictive factor for the existence of foraging areas for many pelagic species (Morato *et al.* 2008). Moreover, in studies using General Linear Models (GLM), the presence of seamounts in a pelagic area, was a predictive factor for the presence of the some pelagic species as Cory's shearwater *Calonectris diomedea* (Ramírez *et al.* 2008). Seamounts in open seas could be regarded as oases in the desert. Seamounts introduce a disruption in the rather homogeneic pelagic environment. This regional discontinuity, that depends on seamounts' characteristics (Morato et al. 2008), often results in local "upwelling-like" phenomena, thus producing a high productivity area in open sea increasing the local food availability for top predators.

Relevant seamounts for this study were compiled from the GEBCO Sub-Committee on Undersea Feature Names (SCUFN) that maintains a world undersea features database and publishes a digital gazetteer, whose last version (January 2009) of names and geographical coordinates has been used to prepare a seamounts GIS layer with the aid of bathymetric information.

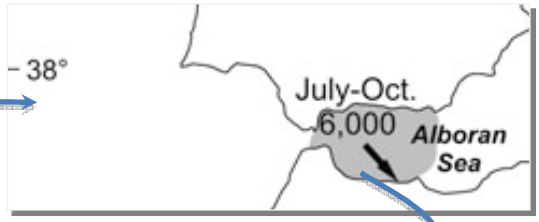
3.3. Information processing

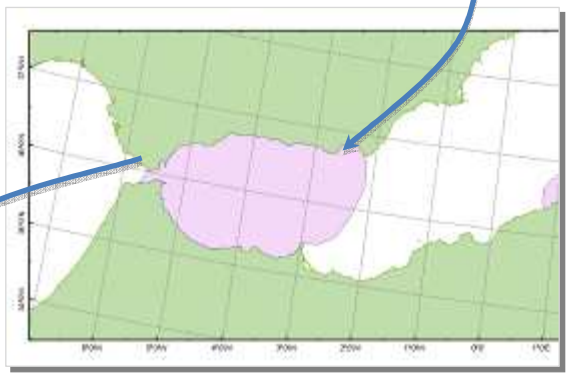
The original European grid was re-scaled to the Mediterranean basin extension excluding inland cells, resulting in 26,736 cells grid covering 2,525,138.004 km^2. Oceanographic factors were translated in this Mediterranean grid using different procedures of spatial join, obtaining different grids collecting information about depth in meters, Chlo-*a* concentration in terms of $mg \cdot l^{-1}$, SST in Celsius degrees, etc, as well as the area covered. Each of the cells has a unique cellcode that identifies resolution, row and column following the EEA operational guide to geographic data and maps (2008), vg: 10kmE315N156.

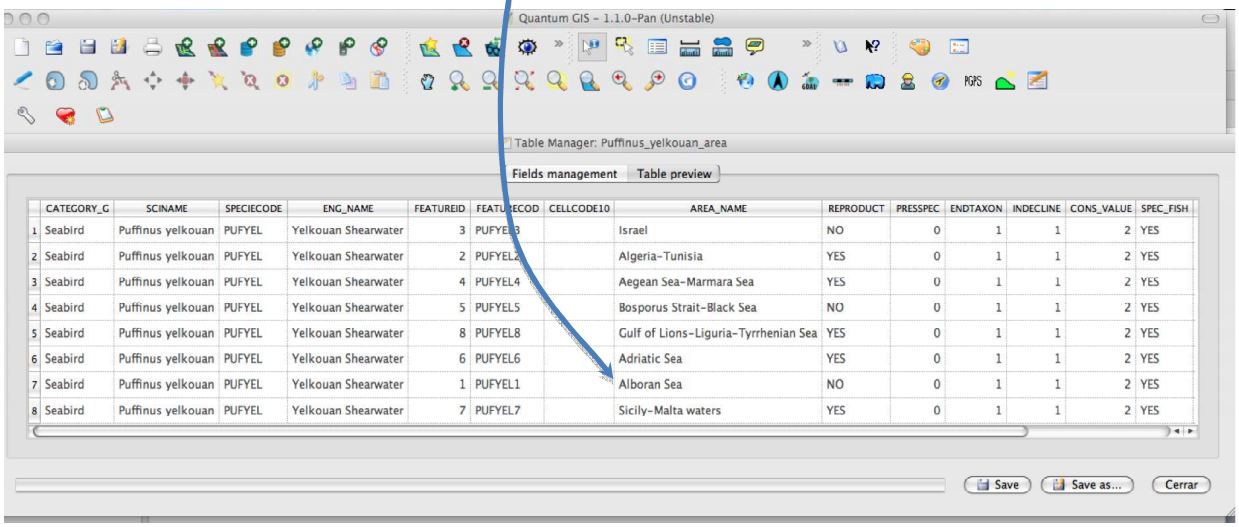
Figure 1 shows the process followed to obtain the georeferenced layers. To prepare the coverage of each of the seabird species considered, in a first step a similar process was applied, depending on the initial format (an existing shapefile or other GIS format, a Google Earth drawing, dot localisations from electronic devices, etc.). In many cases it was necessary to combine different plates illustrating the distribution range of a given species. Initially, except for the case of dots, all the areas were georeferenced by way of a polyline feature. Figure 2 explains the procedure to produce the ranked grids.



Areas of yelkouan shearwater concentration at sea. From Bourgeois & Vidal, 2008.The endemic Mediterranean yelkouan shearwater Puffinus yelkouan: Distribution, threats and a plea for more data. *Oryx*, 42(2), 187-194.







	CATEGORY_G	SCINAME	SPECIECODE	ENG_NAME	FEATUREID	FEATURECOD	CELLCODE10	AREA_NAME	REPRODUCT	PRESSPEC	ENDTAXON	INDECLINE	CONS_VALUE	SPEC_FISH
1	Seabird	Puffinus yelkouan	PUFYEL	Yelkouan Shearwater	3	PUFYEL3		Israel	NO	0	1	1	2	YES
2	Seabird	Puffinus yelkouan	PUFYEL	Yelkouan Shearwater	2	PUFYEL2		Algeria-Tunisia	YES	0	1	1	2	YES
3	Seabird	Puffinus yelkouan	PUFYEL	Yelkouan Shearwater	4	PUFYEL4		Aegean Sea-Marmara Sea	YES	0	1	1	2	YES
4	Seabird	Puffinus yelkouan	PUFYEL	Yelkouan Shearwater	5	PUFYEL5		Bosporus Strait-Black Sea	NO	0	1	1	2	YES
5	Seabird	Puffinus yelkouan	PUFYEL	Yelkouan Shearwater	8	PUFYEL8		Gulf of Lions-Liguria-Tyrrhenian Sea	YES	0	1	1	2	YES
6	Seabird	Puffinus yelkouan	PUFYEL	Yelkouan Shearwater	6	PUFYEL6		Adriatic Sea	YES	0	1	1	2	YES
7	Seabird	Puffinus yelkouan	PUFYEL	Yelkouan Shearwater	1	PUFYEL1		Alboran Sea	NO	0	1	1	2	YES
8	Seabird	Puffinus yelkouan	PUFYEL	Yelkouan Shearwater	7	PUFYEL7		Sicily-Malta waters	YES	0	1	1	2	YES

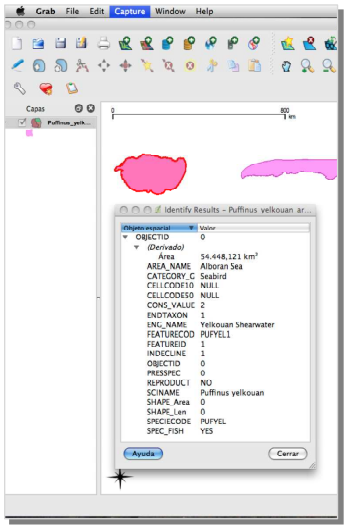


Figure 1. *For each one of the species all the information was compiled in a georeferenced format and assembled in a unique layer. The table of contents of these layers –with the same structure for all the species- was filled in considering the different fields. These fields are the basis to perform queries, selections and to identify each of the features. In the last step of this process, all the individual shapes were compiled into a unique shapefile with all the species and features.*

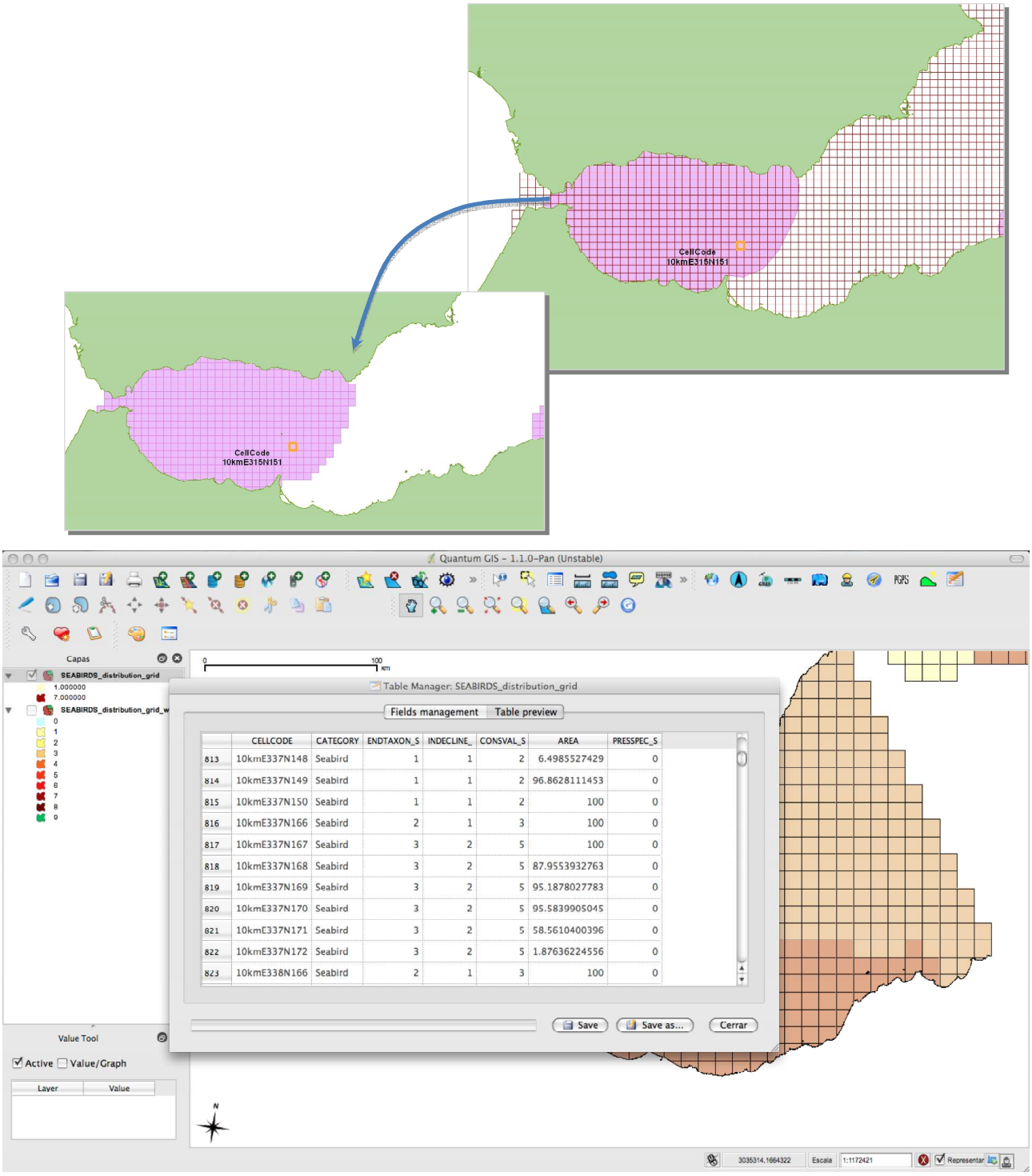


Figure 2. *The previous layer was translated into the EEA reference 10km x 10 km grid for projection "ETRS89-LAEA 52N 10E" in polygon format. The result obtained was a 12.347-cell grid covering 1 114 413,08 square kilometres and a conservation value for each cell ranked from 1 to 7. The final shapefile (a polygon) was obtained after a dissolving procedure over the conservation value thus showing the perimeter of all the resulting areas with their relative conservation value. Each taxon was assigned a value of one (1) 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 value of one to highlight their higher conservation concern. The final shape contents a conservation value field that shows the result of adding all the values for each cell.*

The final conservation value of each 100 km^2 is the result of the following additive process. For any of the layers concerning a unique specie, the next fields of the table of contents can show any of these values.

Field		Possible values
PRESENCE	If a specie is present in the area	yes / no
SPEC-FISH	If a specie is threatened by by-catch	yes / no
ENDTAXON	If a specie is an endemic or near-endemic taxon in the area	0 / 1
INDECLINE	If the specie is in decline in the area	0 / 1
CONSVAL	The sum of all the above factors	0, 1, 2

When the spatial join of all these layers is performed over the Mediterranean grid, each of the cells received a new value that corresponds to the sum of all the species that counts for any given cell. In this way, CONSVAL of a given a cell could be ranked between 0 (if it isn't selected for none of the species) to 11 if this cell counts for all the seven species. In the final result, all the cells ranked between 0 and 7, as can be seen in the next section.

4. Results

4.1. General overview

Treatment of the data allowed for graphic representation (to give way to further analysis along with environmental variables) and for some basic calculations[2]. The latter revealed some trends that are worth mentioning:

a) nearly two-thirds (65.37%) of the sum of cells had insignificant presence of priority species (cat. 0-1)

b) inversely, priority bird species were present in only about one-third (34.63%) of the total cells

c) priority bird species were somewhat dispersed over the areas where they were present; no single cells had a value >7, when the highest possible value was 11

d) nearly one-fourth (25.75%) of the sum of cells corresponded to cat. 2-4; these were assigned 'priority B'

e) less than 10% (8.88%) of the total sum of cells had the highest importance (cat. 5-7) in terms of priority bird species present; these were assigned 'priority A'

Fig. 3 maps the geographical distribution of priority areas for the conservation of seabirds, according to their numerical value. It highlights the heterogeneity of the Mediterranean Sea and the relatively low value –with the available information– of large areas of the ocean. These concentrate mostly in the eastern Mediterranean basin, particularly the southern latitudes. Also, in general terms, deep-water areas are poorer in their presence of pelagic birds.

The distribution of priority B areas marks the influence of large-scale ocean graphical features (increased productivity, mixing of waters, bathymetric zone) and acts as a general indicator of areas of conservation interest for seabirds. Given the paucity of data for some species and regions, priority B areas should be taken as 'good areas' for the development of a network of marine protected areas for the conservation of seabirds.

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, also, outstandingly, in the Straits of Gibraltar.

[2] For the following results and tables, it must be born in mind that they are based on the percentage of the total number of cells that fill a certain condition, and that they only indirectly represent the total area.

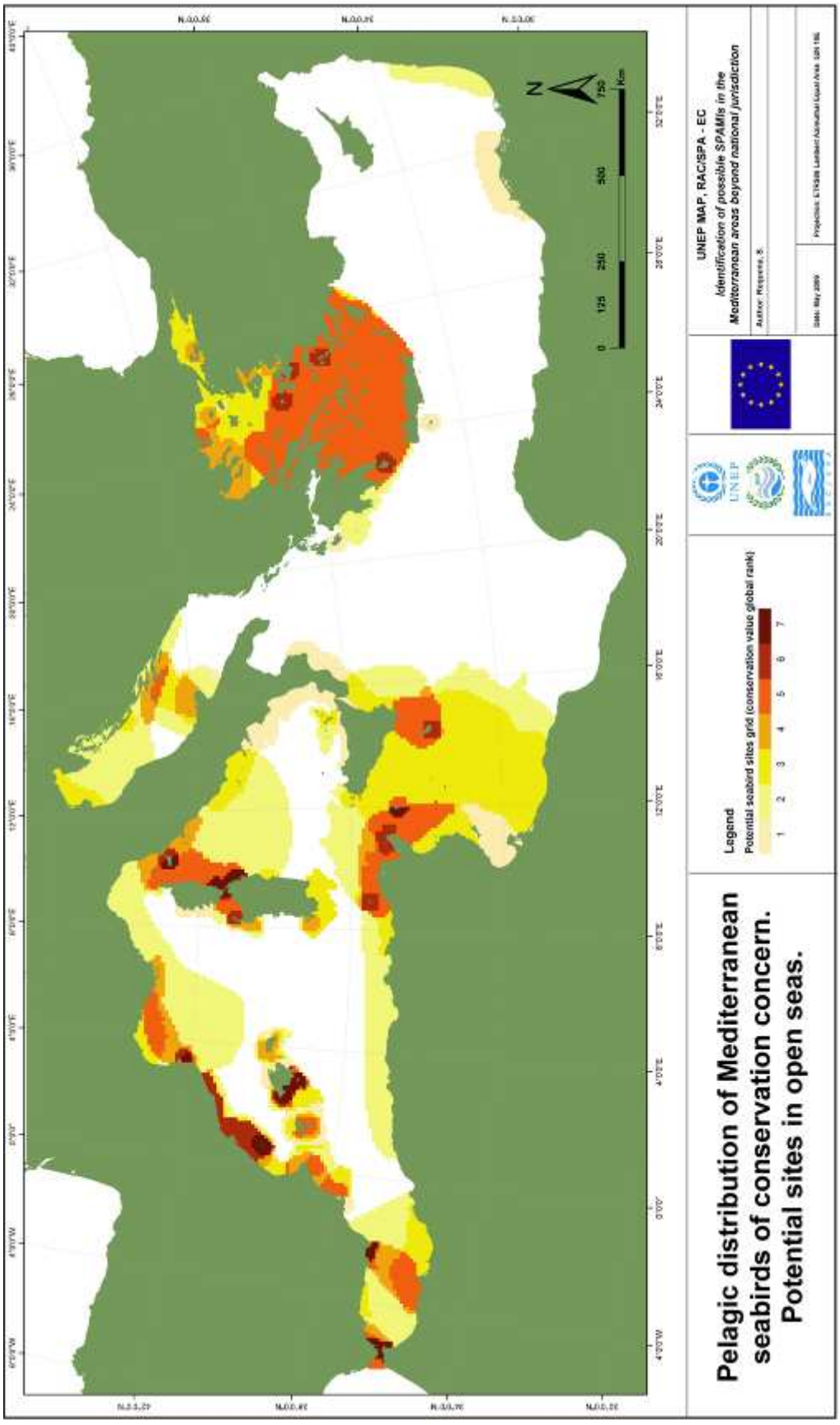
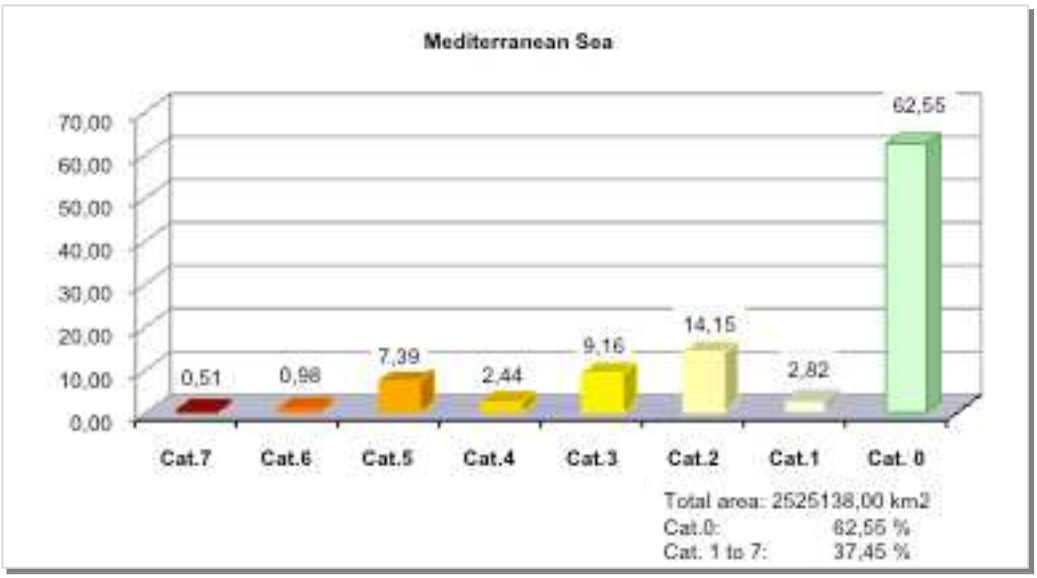

Pelagic distribution of Mediterranean seabirds of conservation concern. Potential sites in open seas.
Legend
Potential seabird sites grid (conservation value global rank)
1 2 3 4 5 6 7
UNEP MAP, RAC/SPA - EC
Identification of possible SPAMIs in the Mediterranean areas beyond national jurisdiction
Author: Requena, S.
Date: May 2009
Projection: ETRS89 Lambert Azimuthal Equal Area
0 125 250 500 750 Km
N
UNEP

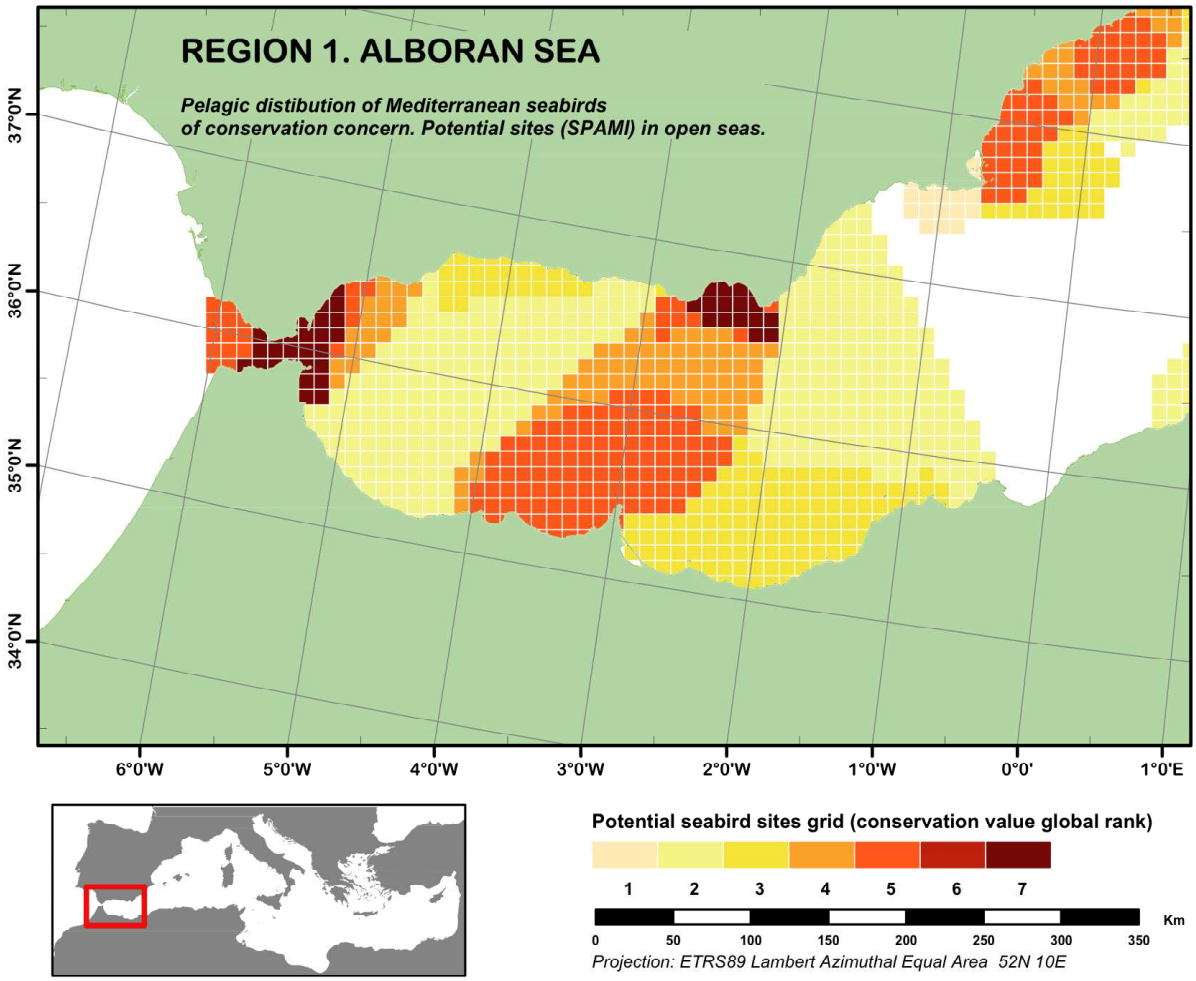
Figure 3.

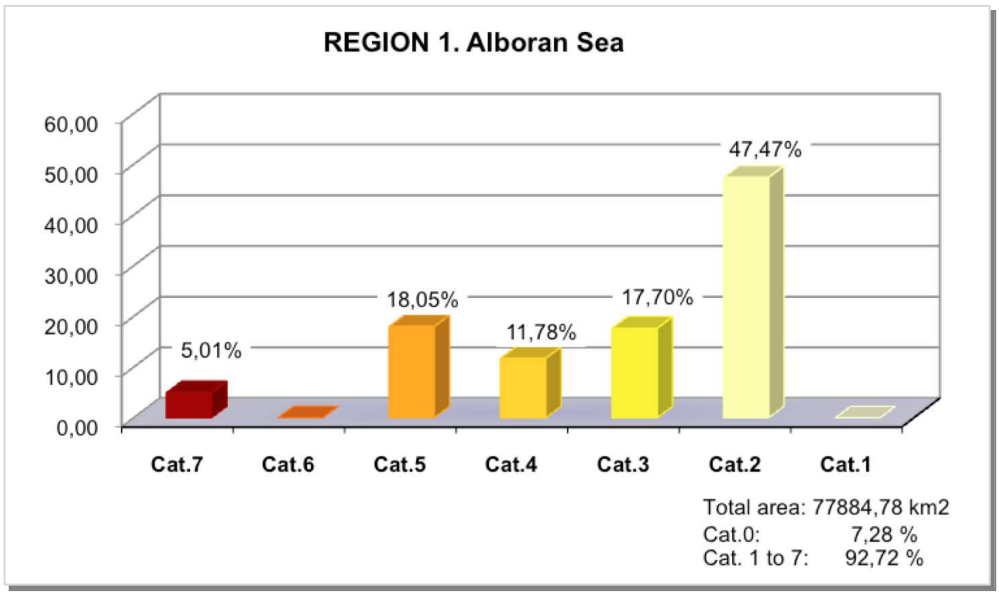


	Area (km2)	**%**
Cat. 0	1579438,39	62,55
Cathegories 1 to 7	945699,61	37,45
Total area Mediterranean Sea	**2525138,00**	100,00
Cathegory		
Cat.7	12900,00	0,51
Cat.6	24700,00	0,98
Cat.5	186599,93	7,39
Cat.4	61700,00	2,44
Cat.3	231399,80	9,16
Cat.2	357299,94	14,15
Cat.1	71099,94	2,82
Sub-total value	**945699,61**	100,00

4.2. Results – by region

4.2.1 Alborán Sea





	Area (km2)	%
Cathegory 0	5670,96	7,28
Cathegories 1 to 7	72213,81	92,72
Total area REGION 1	**77884,78**	100,00
Cathegory		
Cat.7	3614,62	5,01
Cat.6	n.d	n.d
Cat.5	13034,35	18,05
Cat.4	8507,96	11,78
Cat.3	12779,26	17,70
Cat.2	34277,63	47,47
Cat.1	n.d	n.d
Sub-total value	**72213,81**	100,00

ECOSYSTEM OVERVIEW

Two major systems coincide in this relatively small sea: (i) the introgression of cold and rich Atlantic waters, causing two oceanic gyres that create areas of high productivity, and (ii) the funnelling of the Atlantic-Mediterranean flyway, which most migrating seabirds travelling between those seas are obliged to use in their travels.

Its bathymetry is complex, with several seamounts and benthic irregularities. However, the continental shelf is relatively narrow, compared to neighbouring regions, and there are no river systems of substantial size. These characteristics favour the occurrence of the more pelagic species (e.g. shearwaters) but offers less opportunities for the more coastal ones (e.g. shag, terns) which, although present, do not occur in very large numbers.

The area is important throughout the year for foraging, migrating and wintering seabirds. Its significance mainly lies during the migration periods, when it can become crucial for the survival of many populations, including those of the most threatened species. In winter, it holds considerable numbers of both Mediterranean (e.g. Yelkouan shearwater) and Atlantic species (gannet, skuas, alcids), some of which become rare further into the Mediterranean. During the breeding season, this region also serves as an alternative feeding area for species like the Balearic shearwater. The number of islands suitable for breeding is small but nevertheless the area hosts large colonies of Cory’s shearwater and Audouin’s gull.

AREAS OF SPECIFIC ORNITHOLOGICAL IMPORTANCE

- **Straits of Gibraltar**

A key area for the migration of the globally threatened *Puffinus mauretanicus* and near-threatened *Larus audouinii*, as well as for the endemic *Calonectris d. diomedea*. One of the most important ornithological sites in the Mediterranean region and in Europe.

- **Málaga coast**

An important area for wintering *Larus melanocephalus* and for the migration of gulls, shearwaters and several species of seabird of Atlantic origin.

- **Gulf of Almería**

Puffinus mauretanicus regularly concentrate in its waters for foraging, and *Larus audouinii* use the area as a migration stopover site. *Calonectris d. diomedea* and *Phalacrocorax a. desmarestii* also present.

- **Central Alborán sea**

This area forms a natural link between the N and S coastlines; its rich waters concentrate pelagic seabirds for foraging. The small island of Alborán only hosts a minor (c. 200 bp) colony of *Larus audouinii*.

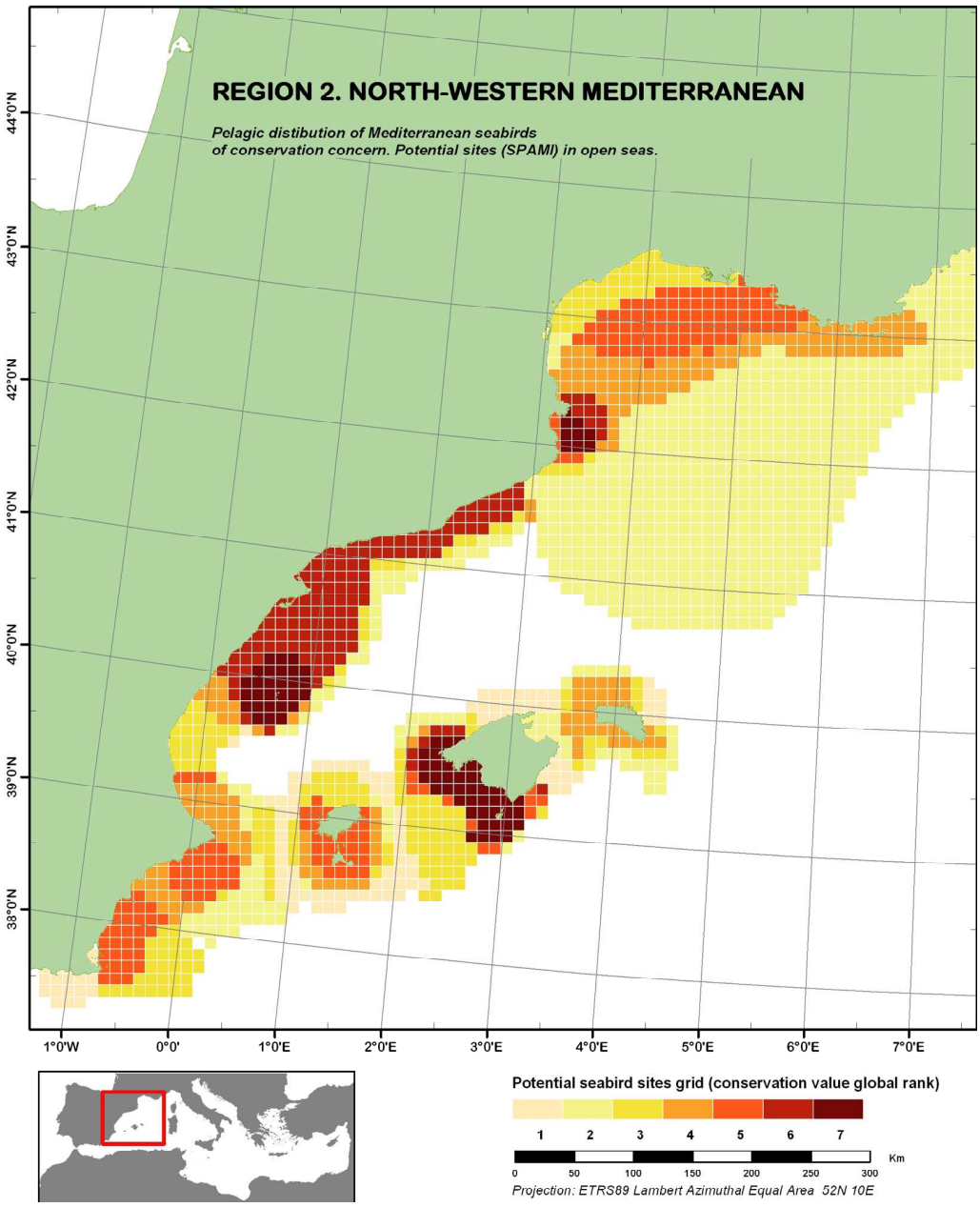
- **Morocco-Algerian coast**

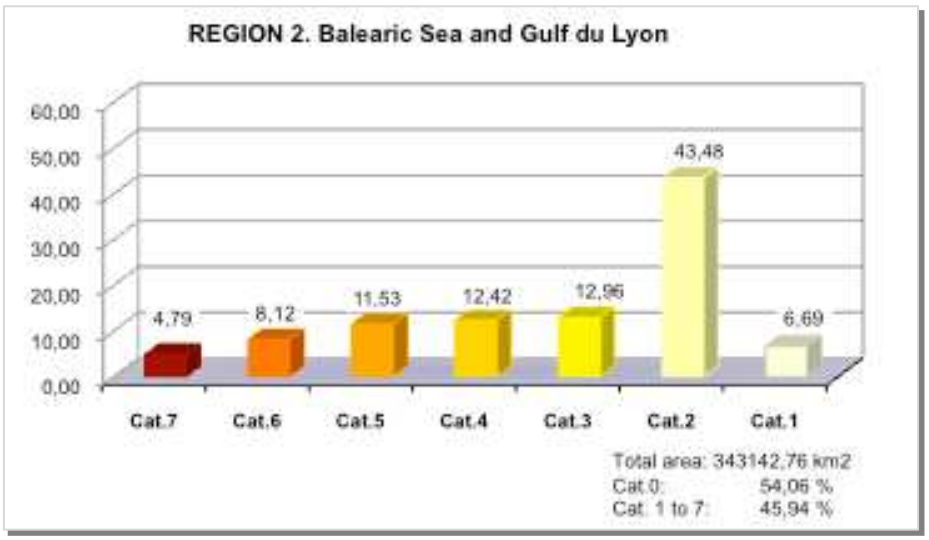
This coastline is similar to the area above but, in addition, offers good nesting sites, particularly in the Chafarinas Is, which supports large breeding numbers of *Calonectris d. diomedea* and *Larus audouinii*. It is also a hotspot for birds of prey, marine mammals and other relevant fauna.

- **Almería-Orán front**

An important oceanographic feature that attracts pelagic seabirds from a wider area. Its role in delimiting populations of *Calonectris d. diomedea* has been noted. It marks the eastern edge of this natural region.

4.2.2 Balearic Sea & Gulf du Lion





	Area (km2)	%
Cathegory 0	185516,05	54,06
Cathegories 1 to 7	157626,71	45,94
Total area REGION 2	**343142,76**	100,00
Cathegory		
Cat.7	7552,03	4,79
Cat.6	12799,73	8,12
Cat.5	18176,47	11,53
Cat.4	19584,20	12,42
Cat.3	20433,07	12,96
Cat.2	68543,83	43,48
Cat.1	10537,38	6,69
Sub-total value	**157626,71**	100,00

ECOSYSTEM OVERVIEW

This large area encompasses two major river systems, the Rhone / Gulf du Lion and the Ebro, plus several archipelagos. The cold waters, particularly in the northern and central sectors, receive nutrients from the river outflows and become highly productive in combination with major oceanographic features (upwellings, fronts); these waters act as an important foraging area for the nesting populations of most globally-threatened seabirds found in the Mediterranean.

Breeding colonies concentrate in island groups that are generally predator-free and far from the continents. Foraging adults need to travel substantial distances and make long trips that can last for several days. The important fishing industry, with several hundred trawling, purse-seining and longline vessels, represents a major disruption of the initial ecosystem conditions and, although in the short term it provides a predictable source of abundant food, in the long run it is impacting on seabird populations heavily by destroying many life forms and their habitats in a non-selective way, and by causing incidental mortality of some species, particularly shearwaters and some gulls.

This area offers what is possibly the best combination of productive waters and breeding habitat, so it is home to all of the species considered for this report; some of them have their largest world populations in this region. However, it also subject to important threats, particularly through habitat degradation and predation by invasive species in the breeding grounds, and intensification of uses at sea.

AREAS OF SPECIFIC ORNITHOLOGICAL IMPORTANCE

- **Gulf du Lion**

The extensive continental shelf is delimited to the north by the mouth of the river Rhone (Camargue natural park), with large breeding populations of gulls, terns and waterbirds, and a succession of canyons at the shelf break, to the south. A major foraging ground for seabirds in all seasons, most notably shearwaters during the breeding season.

- **Îles d'Hyères**

This archipelago is situated near the E edge of this area and holds important breeding populations, including the only colonies of *Puffinus yelkouan* and *Calonectris d. diomedea*, plus *Hydrobates p. melitensis* and *Phalacrocorax a. desmarestii*, off continental France.

- **Cap de Creus**

This major promontory marks the S limit of the Gulf du Lion and is in an area of upwelling. *Puffinus mauretanicus* and *P. yelkouan* form large temporary aggregations and are joined by *Calonectris* further offshore. It is a regular home of cetaceans too.

- **Ebro delta & river system**

The Ebro delta natural park is famous for hosting the world's largest (>70 %) colony of *Larus audouinii*; other gulls and terns breed there as well. Its offshore waters are a main haunt for feeding shearwaters and other birds from the Balearic islands. A main wintering area for *Larus melanocephalus*.

- **Columbretes Is.**

A small archipelago of volcanic origin, it hosts breeding *Calonectris d. diomedea*, *Phalacrocorax a. desmarestii* and *Larus audouinii*, plus Eleonora's falcon *Falco eleonorae*. The sorrounding waters are a marine reserve and SPAMI.

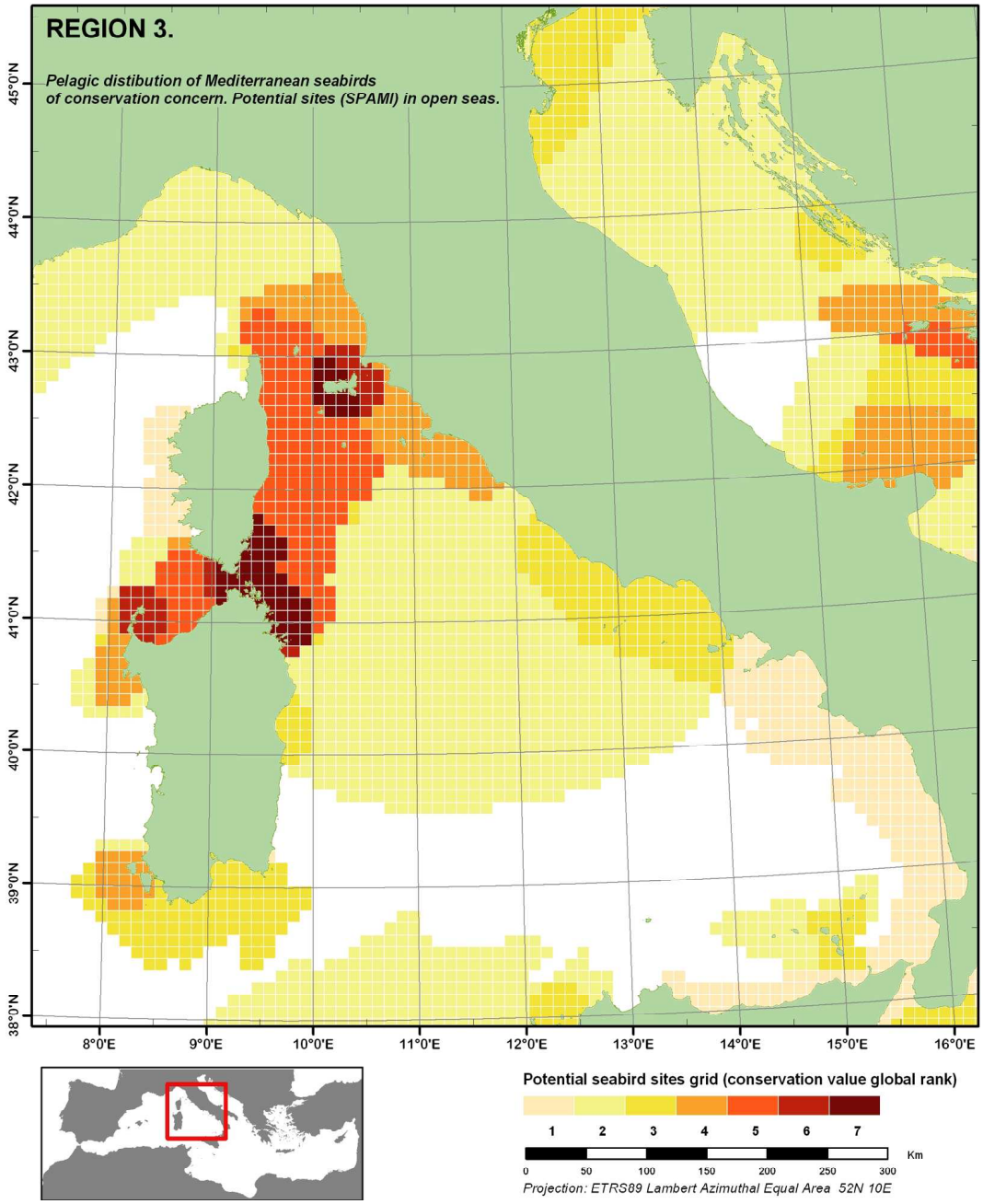
- **Balearic Is.**

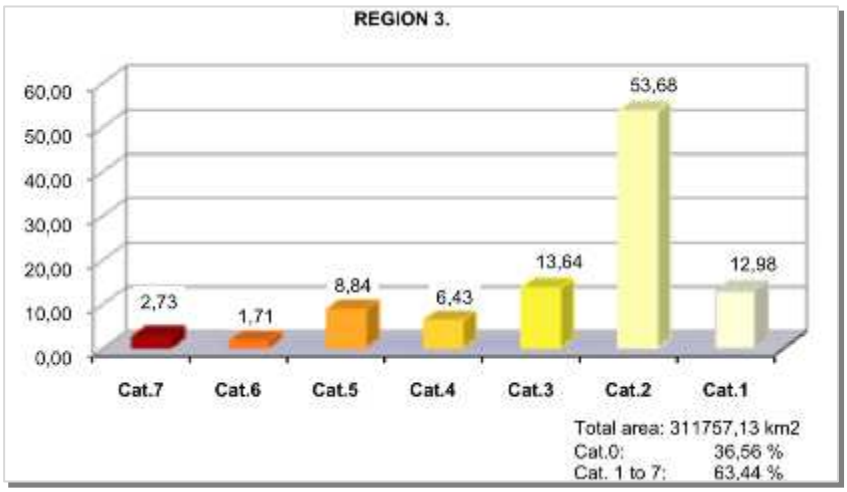
Home to the endemic *Puffinus mauretanicus*, this archipelago is a major tourist destination but still maintains some natural habitats. 6 of the 7 species considered in this report breed on its various islands, plus Osprey *Pandion haliaetus* and Eleonora's falcon *Falco eleonorae*. The waters surrounding the colonies are a secondary feeding ground for most seabirds, which feed off continental Spain.

- **Cap de la Nau**

Orographically, this calcareous massif marks the S limit of the Balearic Sea. Strong marine currents generate eddies and areas of high productivity, that extend S to Murcia and Cape Palos. Shearwaters, storm-petrels and *Larus audouinii* use these waters extensively for feeding.

4.2.3 Tyrrhenian & Ligurian Seas





	Area (km2)	%
Cathegory 0	113982,57	36,56
Cathegories 1 to 7	197774,57	63,44
Total area REGION 3	**311757,13**	100,00
Cathegory		
Cat.7	5400,02	2,73
Cat.6	3373,73	1,71
Cat.5	17475,35	8,84
Cat.4	12723,19	6,43
Cat.3	26977,82	13,64
Cat.2	106159,62	53,68
Cat.1	25664,83	12,98
Sub-total value	**197774,57**	100,00

ECOSYSTEM OVERVIEW

This large, productive area is the eastern counterpart of the previous zone. It is geologically more complex and lacks the strong influence of major rivers but nevertheless hosts significant populations of marine top predators, notably cetaceans and also seabirds. In the northern half of the region, waters are shallower and the continental shelf is extensive, currents are strong and there is a lot of mixing of waters; productivity is relatively high. To the south, waters are considerably deeper and of less interest for seabirds.

Two main islands –Corsica and Sardinia– several archipelagos and minor island groups are to be found in this region, and offer seabirds a choice of opportunities for breeding. The waters on the continental shelf are favoured for feeding, so considerable journeys may be implied in some cases.

All 7 species covered in this report are in this region, except for Balearic shearwater. Yelkouan, its eastern counterpart, breeds mostly in the northern half. Cory's breed throughout, favouring the more productive waters on the shelf for feeding, where they possibly coincide with European storm-petrels. Shags find favourable habitat in these waters, particularly around the larger islands, where they have large populations. Audouin's gulls are present but in relatively small numbers, as their habitat is far from ideal. Mediterranean gulls occur in winter along the continental coast of central and southern Italy.

AREAS OF SPECIFIC ORNITHOLOGICAL IMPORTANCE

- **Tuscan coast & islands**

The islands support breeding *Puffinus yelkouan*, *Calonectris d. diomedea* and *Larus audouinii*; foraging occurs in the rich waters between the islands and the continent. *Phalacrocorax a. desmarestii* also breed, and disperse over the immediate waters.

- **N & E Corsica**

Small breeding populations of *Calonectris d. diomedea* and *Larus audouinii* occur in these waters that are used by seabirds of several species, mostly from colonies in adjacent areas, for feeding.

- **Corsican-Sardinian islands & shelf**

Possibly the main breeding haunts for 5 species in the region, this rugged coast, spotted with many islands, is relatively well preserved. Several natural parks and protected areas have been set up to preserve their biodiversity. The breeding birds spread for feeding over near and distant waters, making this a main centre of seabird activity.

- **NW Sardinia**

Home to large colonies of *Calonectris d. diomedea* and *Puffinus yelkouan* shearwaters and smaller numbers of the other species, its cliffs and islands provide good breeding habitat. Good foraging areas offshore.

- **S Sardinia**

The distant waters are an important feeding area for procellariiforms (shearwaters, storm-petrels), with relatively small breeding numbers of *Calonectris d. diomedea*, *Larus audouinii* and *Phalacrocorax a. desmarestii* on the few islands available.

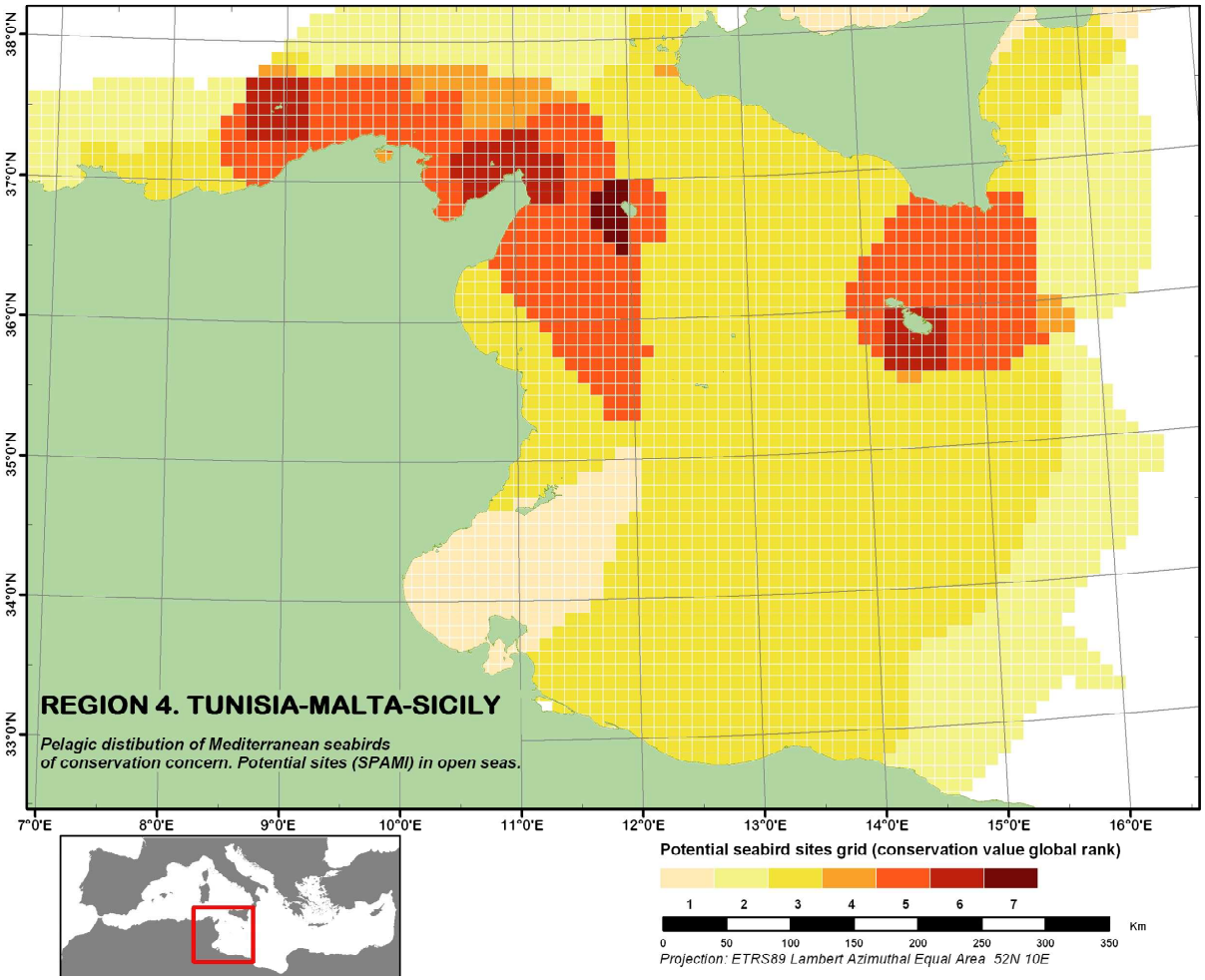
- **Lazio coast**

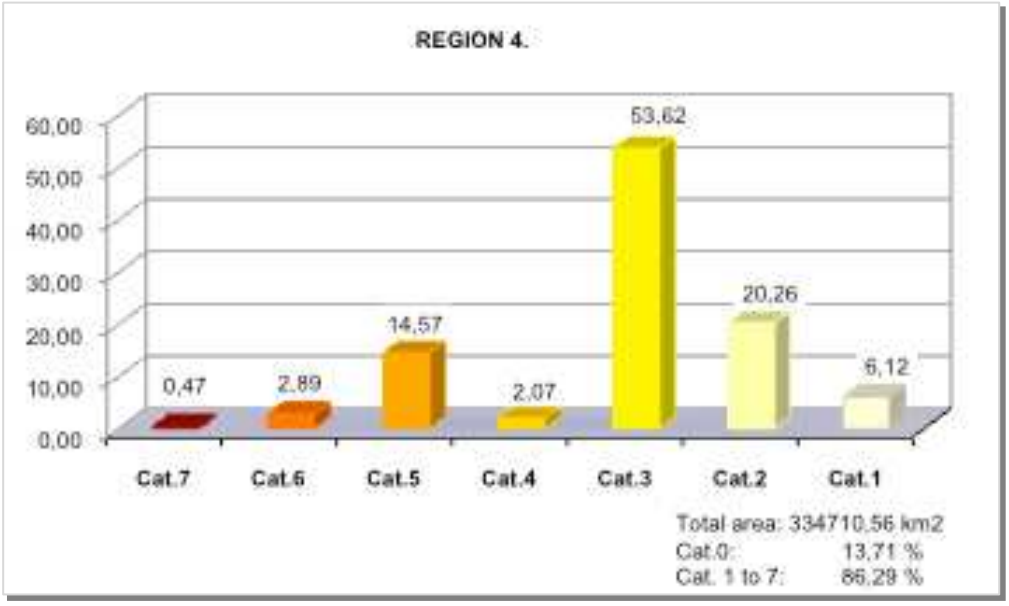
This area is mainly known for its value for foraging shearwaters from the Sardinian and Aeolian colonies and for wintering *Larus melanocephalus*.

- **Aeolian islands**

These unique islands of volcanic origin are important for breeding *Calonectris d. diomedea.*

4.2.4 Tunisia – Malta – Sicily





	Area (km2)	%
Cathegory 0	45892,27	13,71
Cathegories 1 to 7	288818,28	86,29
Total area REGION 4	**334710,56**	100,00
Cathegory		
Cat.7	1364,01	0,47
Cat.6	8345,85	2,89
Cat.5	42066,81	14,57
Cat.4	5989,08	2,07
Cat.3	154866,58	53,62
Cat.2	58515,02	20,26
Cat.1	17670,93	6,12
Sub-total value	**288818,28**	100,00

ECOSYSTEM OVERVIEW

Situated in the transition zone between the eastern and western basins, this region is one of the most important in the Mediterranean, in terms of biological productivity and bird life. It lacks rivers of any significant size, but abundant nutrients are afforded by the mixing of waters in the Strait of Sicily-Tunisia (Cap Bon Channel) and by the washing of the phosphat-rich littoral in the Gulf of Gabès.

Morphologically, this region is rather uniform both in bathymetry and in the shape of the coast. A few island groups are strategically situated in the main corridor between east-west Mediterranean, and have traditionally supported large colonies of breeding procellariiforms (shearwaters, storm-petrels). This area is also in the crossroad between S Europe and N Africa, and human history has played a role in strategic occupation and abandonment of some island territories, with variable consequences on their bird populations.

Procellariiforms (*Calonectris d. diomedea, Puffinus yelkouan, Hydrobates p. melitensis*) form the basis of the seabird community, which on the other hand is rather poor in shag and gull numbers. Lesser-crested Tern *Sterna bengalensis* holds here a unique population in the Mediterranean, but the species is not known to frequent offshore waters in sufficient numbers to include it in this report.

AREAS OF SPECIFIC ORNITHOLOGICAL IMPORTANCE

- **Strait of Sicily-Tunisia / Cap Bon Channel**

The area comprises two important island groups, Zembra-Zembretta and Galite archipelago (*Calonectris d. diomedea, Phalacrocorax a. desmarestii, Larus audouinii*). Its waters offer good feeding opportunities for these and other species (shearwaters, storm-petrel), including gulls and terns in migration and in winter.

- **Egadi Is., Pantelleria & Pelagie Is.**

This area is ecologically analogous to the previous one, with which it forms a continuum, and their seabird colonies are probably interrelated. However, *Larus audouinii* is not present and *Phalacrocorax a. desmarestii* is here at the edge of its distribution. The offshore waters are equally rich and abundant in bird life.

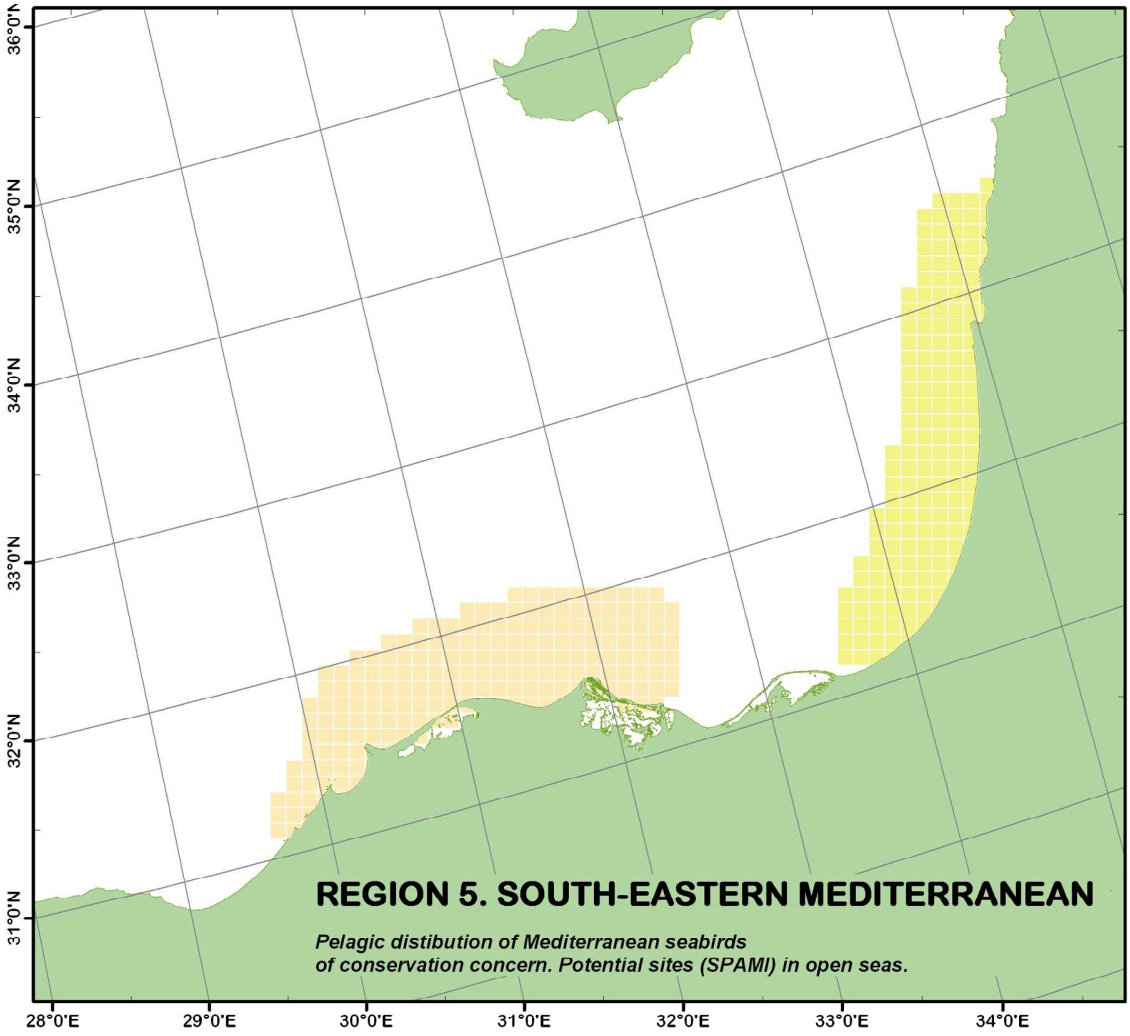
- **Malta & S Sicilian waters**

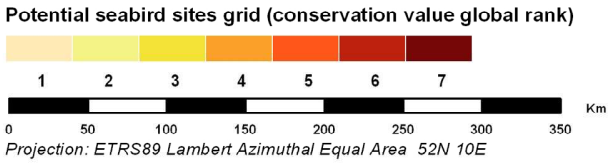
Malta is a larger archipelago and its waters form a hotspot of productivity that extends to the limits of the continental shelf and to the N, to the coast of Sicily. The seabird community is almost exclusively made of procellariiforms (*Calonectris d. diomedea*, *Hydrobates p. melitensis* and *Puffinus yelkouan*, the latter being absent from other island groups in the region). The area supports a wintering population of *Larus melanocephalus*.

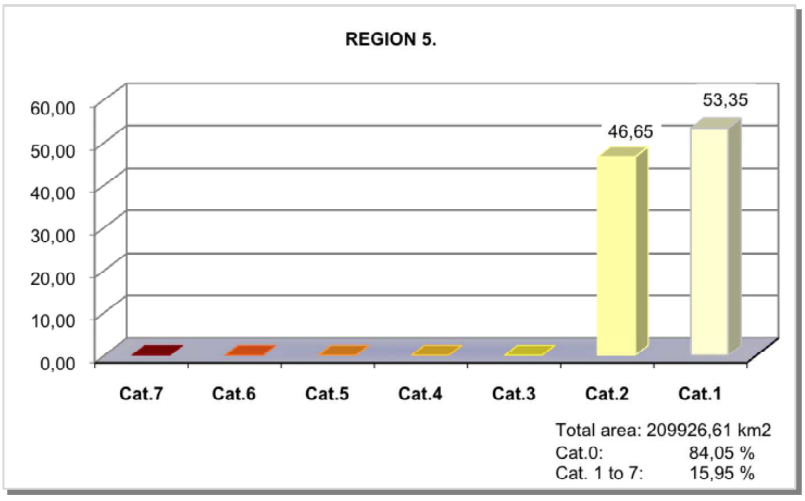
- **Tunisian-Lybian waters**

This area extends between the outer limits of the Gulf of Gabès, to the west, and the continental slope, to the east. Its waters are shallow and productive, and the area is one of the truly pelagic hotspots for seabirds in the Mediterranean. They are important mostly for feeding procellariiforms, with *Sterna bengalensis* close to the coast.

4.2.5 South-eastern Mediterranean







	Area (km2)	%
Cathegory 0	176434,40	84,05
Cathegories 1 to 7	33492,21	15,95
Total area REGION 5	**209926,61**	100,00
Cathegory		
Cat.7	n.d	n.d
Cat.6	n.d	n.d
Cat.5	n.d	n.d
Cat.4	n.d	n.d
Cat.3	n.d	n.d
Cat.2	15623,87	46,65
Cat.1	17868,35	53,35
Sub-total value	**33492,21**	100,00

ECOSYSTEM OVERVIEW

The south-eastern corner of the Mediterranean is an area of poor, hot waters and productivity is much lower than that of the other regions. The important discharge of the river Nile (significantly reduced, compared to historical times) does not bring in enough nutrients and fresh water to compensate, and the region remains relatively unimportant for seabirds. Evaporation is high and there are no other large rivers, apart from the Nile, so sea surface temperature and salinity are high; none of these factors favour productivity. The Suez canal represents an open connection with the Red Sea, an additional source of warm water.

Only two species, *Puffinus yelkouan* and *Larus melanocephalus* are worth noticing, among those covered by this report. To these, a few gulls and terns may be added but their populations are not relevant at global scale.

Further, the area has a lack of islands that could support breding colonies of any size, and only a few coastal sites hold nesting Sternidae (terns) and Laridae (gull) species.

AREAS OF SPECIFIC ORNITHOLOGICAL IMPORTANCE

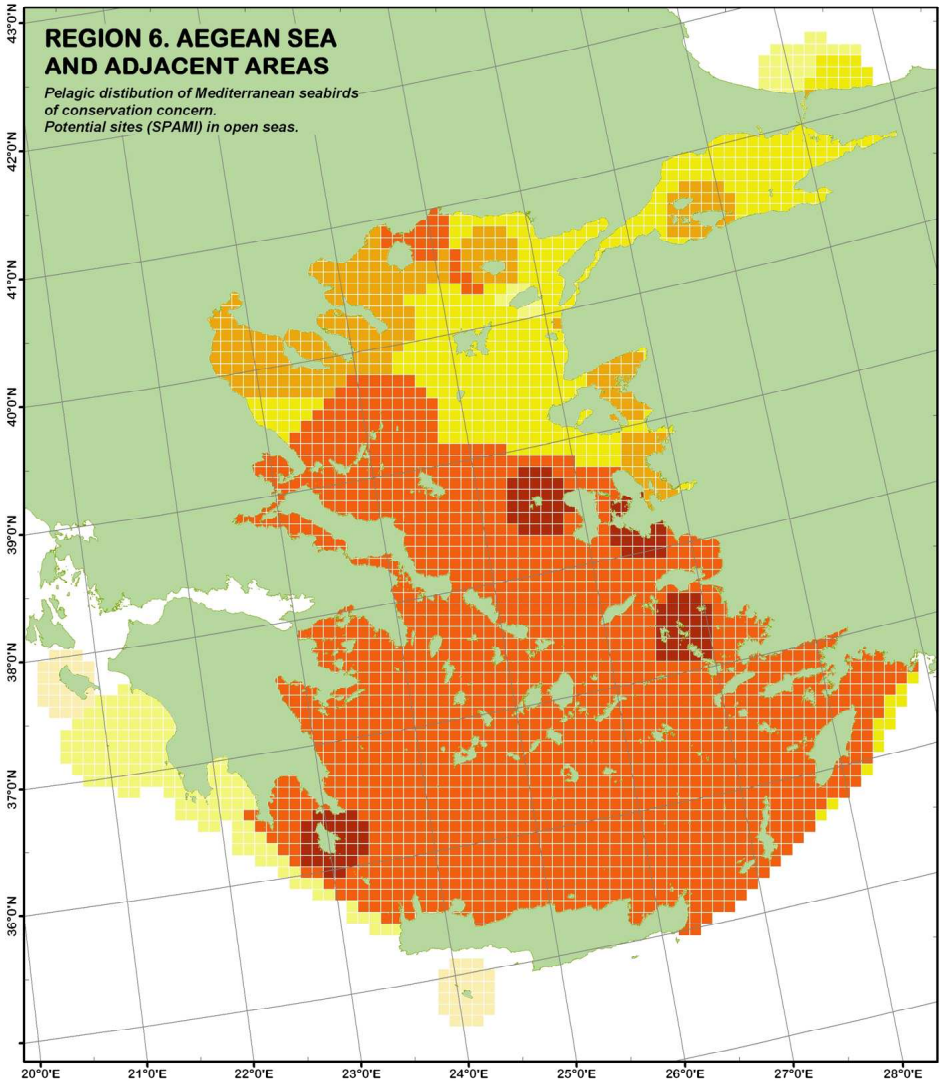
- **Nile river system**

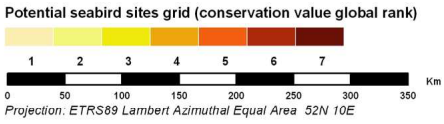
The delta of the river Nile and its wealth of wetlands and lagoons hold considerable numbers of waterbirds, including various gull and tern species, throughout the year but most notably during the migration periods and in the winter season. Of these, only *Larus melanocephalus* is truly pelagic.

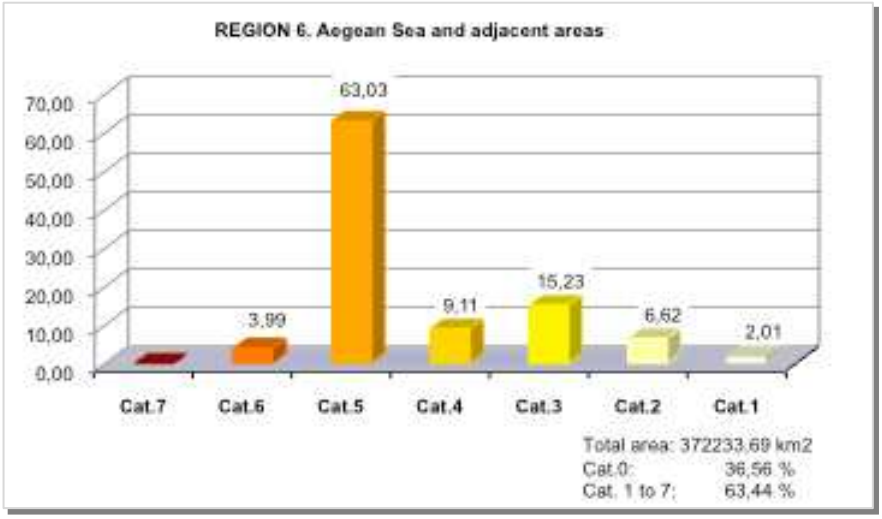
- **Levantine coast**

This homogeneous stretch of coast, and the waters offshore, are known for supporting a wintering population of *Puffinus yelkouan*.

4.2.6 Aegean Sea and adjacent areas







	Area (km2)	%
Cathegory 0	136097,64	36,56
Cathegories 1 to 7	236136,05	63,44
Total area REGION 6	**372233,69**	100,00
Cathegory		
Cat.7	n.d	n.d
Cat.6	9428,19	3,99
Cat.5	148825,64	63,03
Cat.4	21515,11	9,11
Cat.3	35973,63	15,23
Cat.2	15637,95	6,62
Cat.1	4755,53	2,01
Sub-total value	**236136,05**	100,00

ECOSYSTEM OVERVIEW

This area forms a distinct subregion of the Mediterranean sea, both geographically and oceanographically, and this is reflected in its community of seabirds. It is geomorphologically complex, with many islands, straits, deltas and depths, all of which add to its diversity.

The discharge of the Black sea represents a major source of cold water that is rich in nutrients; several river outflows contribute to this and increase its potential for productivity. The region is overall rich and hosts 6 of the 7 species considered in this report, although average colony size is quite low compared to the western half of the Mediterranean. Breeding habitat is in no shortage, particularly for those species that choose to nest on islands.

Several outlying water masses, particularly the Black & Ionian seas, offer long-distance foragers (shearwaters, storm-petrels) additional choices. *Puffinus yelkouan*, feeding on clupeids, finds favorable conditions in this interface, and regularly moves between the Aeegan and the Black sea to exploit this abundant resource. Audouin's gulls colonies are scattered over many islands and islets, often changing location from one year to the next. Mediterranean gulls have set up colonies at several coastal wetlands, along with several species of gulls and terns.

AREAS OF SPECIFIC ORNITHOLOGICAL IMPORTANCE

- **Southern Aegean Sea – Sea of Crete**

This area has the deepest waters and supports considerable populations of breeding *Calonectris d. diomedea*, *Puffinus yelkouan*, *Hydrobates p. melitensis* and *Larus audouinii*. Shags *Phalacrocorax* are found on numerous islets. The more oceanic waters to the S probably have the highest value for procellariiforms.

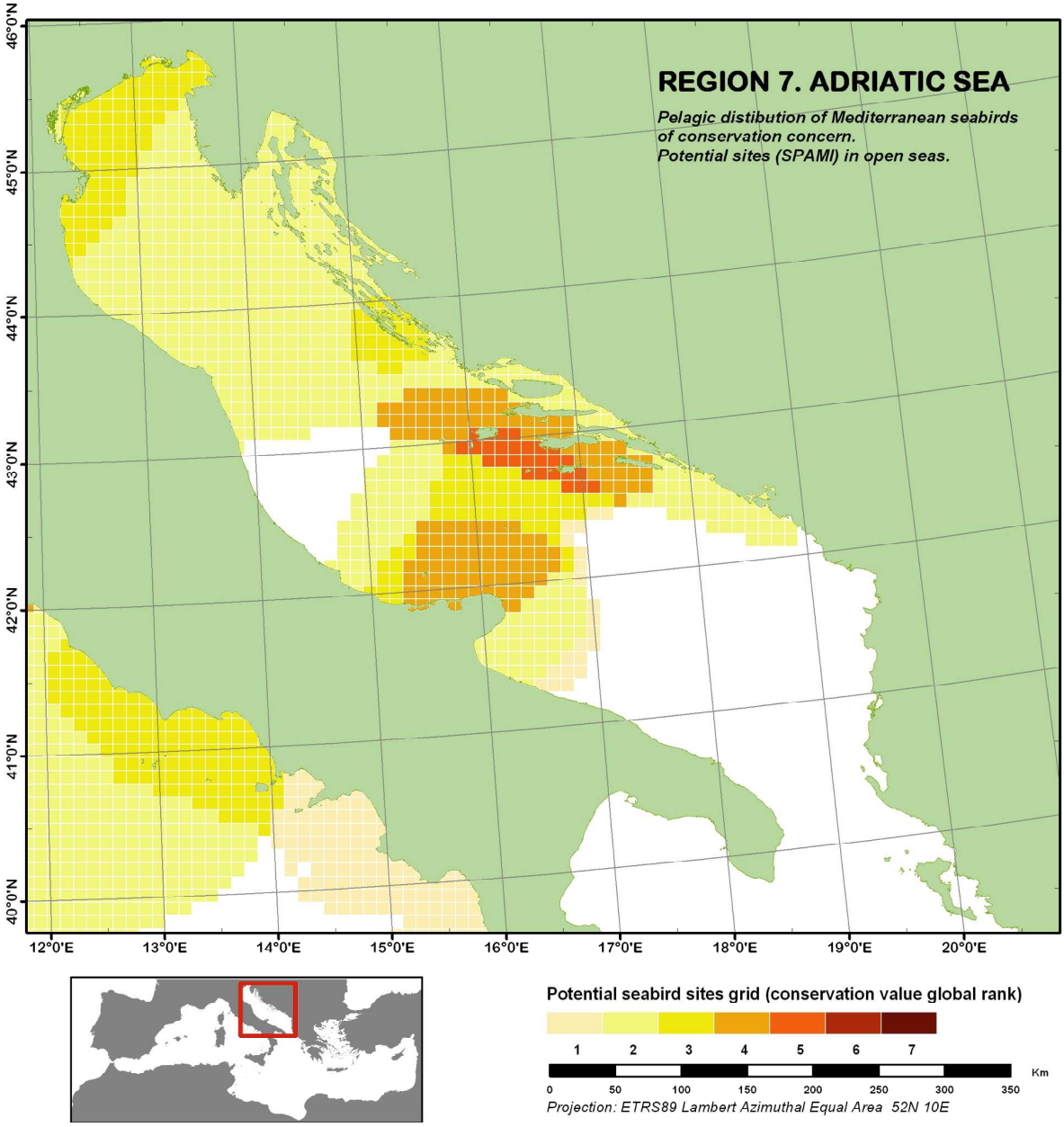
- **Northern Aegean Sea – Thracian Sea**

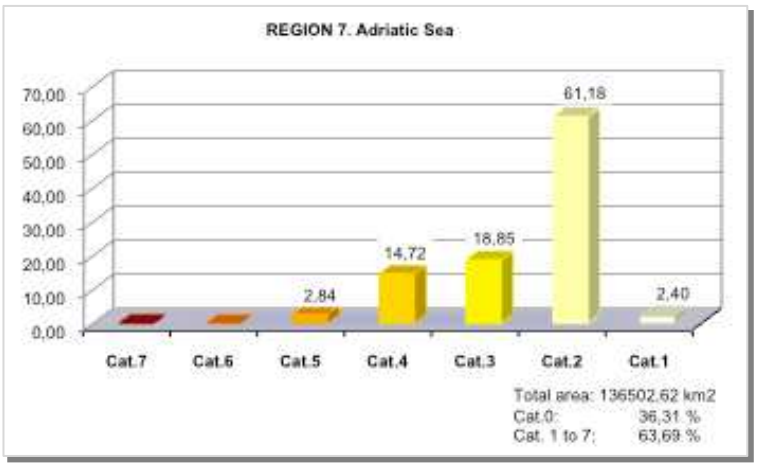
Shearwaters and Audouin's gulls frequent the S half of this area. The N coast is home to *Larus melanocephalus* colonies.

- **Sea of Marmara, Bosporus and Dardanelles**

These two straits and inland body mass make a unique environment in the transition between the Black sea and the Aegean/Mediterranean. This area is particularly important for *Puffinus yelkouan*. Other species (shag, gull, terns) also inhabit these waters.

4.2.7 Adriatic Sea





	Area (km2)	%
Cathegory 0	176434,40	84,05
Cathegories 1 to 7	33492,21	15,95
Total area REGION 5	**209926,61**	100,00
Cathegory		
Cat.7	n.d	n.d
Cat.6	n.d	n.d
Cat.5	n.d	n.d
Cat.4	n.d	n.d
Cat.3	n.d	n.d
Cat.2	15623,87	46,65
Cat.1	17868,35	53,35
Sub-total value	**33492,21**	100,00

ECOSYSTEM OVERVIEW

This part of the Mediterranean has some peculiar physical and biological characteristics and is best described as an interface between brackish wetlands to the north to truly marine habitat when it joins the Ionian sea to the south. The Gulf of Venice receives a considerable discharge of freshwater and its wealth of marshes and lagoons hosts many species of gulls, terns and waterbirds in all seasons. The waters are extremely shallow, procellariiforms are scarce, and only *Puffinus yelkouan* can make use of these productive waters that abound in clupeids and other small fish.

Further S, several island groups in the central Adriatic sea provide nesting habitat for shearwaters, shag and Audouin's gull. In this area there are also several coastal lagoons and salt pans that provide nesting space for gulls and terns. The mixing of waters is most pronounced in this section, which probably offers the best conditions for seabirds.

6 of the 7 species considered for this report frequent the Adriatic sea, including the European storm-petrel that is considered rare, according to current knowledge.

AREAS OF SPECIFIC ORNITHOLOGICAL IMPORTANCE

- **Gulf of Venice**

The wider Gulf of Venice comprises a long series of wetlands and river mouths that support large numbers of several tern and gull species, including *Larus melanocephalus*. Offshore, the area is home to regular aggregations of *Puffinus yelkouan*. Shags *Phalacrocorax a. desmarestii* are present along the coast of Slovenia and Croatia.

- **Central Adriatic Sea**

A few thousand *Calonectris d. diomedea* and smaller numbers of *Puffinus yelkouan* nest on the islands of this coast. *Phalacrocorax a. desmarestii* and *Larus audouinii* are present on the coast and *Larus melanocephalus* nest on the coastal salt pans and frequent the offshore waters.

5. Conclusions - Recommendations

Given the observed at-sea distribution in the Mediterranean Sea, conservation of seabird species of special concern (endemic and declining species) can be best afforded by establishing a network of marine protected areas.

Priority A & priority B areas, as described in this report, should be taken as the basis for this network. The network should seek to be coherent and representative, and aim to include enough marine habitat in the areas occupied by all species.

Specially Protected Areas of Mediterranean Interest (SPAMIs), as established by the SPA/BD Protocol, are an appropriate conservation tool for the purpose of establishing this network. SPAMIs should be further developed to be independent of national legislation and policies, and to allow for the establishment and shared management of sites in waters pertaining to various States, or on Areas Beyond National Jurisdiction.

Information on seabird distribution should be completed and updated so that the distribution of marine areas for seabird protection matches the best available knowledge on seabird use of the Mediterranean. Data obtained from monitoring with remote telemetry devices (PTTs, GPSs, GLSs, etc.) should be used, as they become available, to complement such information and to provide quantitative evidence of use.

The transformation of distribution data into standardised grid-based data is recommended as a basis for further work. As shown in this report, grid-based geographical information may facilitate calculations, comparisons and standardisation of data. For the scale of the Mediterranean Sea, a 10x10 km square grid is the most appropriate.

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