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10.2. Regional Working Programme for the Coastal and Marine Protected Areas in the Mediterranean Sea including the High Seas

10.2.1. Activities for the identification and creation of SPAMIs in the open seas, including the deep seas

Alboran Sea: Ecology and human activities (draft report)

UNEP/MAP
RAC/SPA - Tunis, 2015

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Foreword

Since 2008, the Regional Activity Centre for Specially Protected Areas (RAC-SPA) under the framework of the Mediterranean Action Plan (MAP) of the United Nations Environment Programme (UNEP) has been implementing the "MedOpenSeas" project to identify and establish Marine Protected Areas (MPAs) in the open seas, including the deep seas. The primary objective of this project is to promote the establishment of a representative ecological network of MPAs in the Mediterranean within the framework of the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD Protocol) on the establishment of Specially Protected Areas of Mediterranean Importance (SPAMIs). The first phase of the project, completed in late 2009, led to the identification of twelve priority conservation areas in the open seas, including the deep seas. These priority areas could become candidates for SPAMI listing and/or be recommended for inclusion in other frameworks, such as Ecologically or Biologically Significant Areas (EBSAs) developed under the Convention on Biological Diversity (CBD). The aim of the project's second phase, completed in early 2012, was to support neighbouring Parties of the above-mentioned priority areas in evaluating and potentially presenting these sites as candidate(s) for inclusion in the SPAMI List, in accordance with the provisions of the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean.

The present document corresponds to the third phase of the MedOpenSeas project, which focuses on the spatial planning and evaluation of three priority areas: Adriatic Sea, Alboran Sea and Sicily Channel/Tunisian Plateau.

This report concerns the Alboran Sea and is the synthesis of the four previous reports:

- Fisheries report
- Cetacean report
- Birds report
- Ecological report

This report is intended to replace the draft report on ecology and to be renamed as Ecology, marine activities and options for conservation.

Introduction

In 2007, the IUCN Centre for Mediterranean Cooperation started an informal process with representative of administrations and experts from Algeria, Morocco and Spain for the identification of marine sites or marine species in need of conservation or protection and their consideration within a context of sustainable development of the Alboran Sea. The ultimate objective was to propose guidelines for the co-management of the area between the three countries and therefore to initiate a more formal process between the three countries.

The first steps have allowed to gather and synthetize the existing information that was organized in two publications, in 2010 and 2012 and more recently, in 2014, the creation of a geoportal for Alboran (2014). The reader can consult these two reports and have access to the geoportal:

- Robles, R. (2010). Conservation and sustainable development of the Alboran Sea. IUCN Gland, Switzerland and Malaga, Spain.114 pages. (Edited only in French and Spanish).*https://cmsdata.iucn.org/downloads/libro_alboran_en_fot.doc*
- UICN (2012). Towards as representative network of marine protected areas in the Alboran Sea. IUCN Gland, Switzerland and Málaga, Spain, 124 pages. (Edited only in French and Spanish).https://cmsdata.iucn.org/downloads/medras_alboran_esp_fra_1.pdf
- Geoportal in 3 languages http://www.iucn-geoportalboran.org/fr/ - http://www.iucn-geoportalboran.org/en/ - http://www.iucn-geoportalboran.org/es/

As it is a continuous process, additional information can be provided to IUCN Med and RAC/SPA. For IUCN, it will be analysed for inclusion in the next report or added to the geoportal for the geographical information.

In 2013, RAC/SPA, mandated by the Parties to the Barcelona Convention has started a more formal process with the three countries, building on the initial data collection and analysis and is moving forward for a joint management of the Alboran Sea area.

1. General characteristics of the Alboran Sea

The Alboran Sea, between Spain, Morocco and Algeria is inthe western most región of the Mediterranean.Its width is a minimumof 14 kmin the Strait of Gibraltar and extends on up to about 180 kmto the east (Figure 1). From West to East, the distance is about 350 km from the Strait of Gibraltar to the line between the Cape of Gata (Almeria, Spain) and Cape Fegalo (Oran, Algeria). This imaginary line does not define a strict physical border but a rough delineation of ecological processes and existing physical characteristics permanently fluctuating between these boundaries but according to seasonal oceanographic conditions.

The Alboran Sea is boarded by the provinces of Malaga, Granada and Almeria in Andalusia (Spain); Tangier-Tetouan, of Tazar-Al Hoceima-Taounate and the Oriental in Morocco; Tlemcen, Ain Timouchent and Oranin Algeria.

The Alboran Sea is a unique due to its great ecological importance and is a biogeographic boundary due to the strong influence and dynamics of exchanges between water masses from the Atlantic through the Strait of Gibraltar, and those of the Mediterranean.

The particular geomorphological and hydrodynamic characteristics that converge in this región have modeled the existing biodiversity and ecosystems with an abundance of biological resources greater than those of other regions of the Mediterranean. The mixture of Atlantic and Mediterranean waters creates optimal conditions for the establishment of mixed communities, communities dominated by species of European or Mediterranean Atlantic origin, species of fauna and flora of the subtropical Northeast Africa, as well as endemic species of this sea, generating a fantastic and unique richness and a diversity of habitats.

In addition, the Alboran Sea is a place of passage and transition for migratory species of cetaceans, turtles, sea birds or large pelagic species such as bluefin tuna. The geomorphological variety of its Deep waters created the optimal conditions for a wide variety of species associated with mountains and submarine canyons, coral reefs of cold water or the communities associated with carbonate mounds and mud volcanoes.Much of these habitats are authentic "oasis" for biodiversity and harbouring fragile ecosystems.

The presence of upwelling waters rich in nutrients and of various hydrological conditions generate an abundant and high planktonic productivity, superior to other Mediterranean regions. This high productivity supports the growth of many species, including the presence of spawning grounds for commercially important species for fishing (tuna, swordfish, sardines, anchovies, etc.).

1.1. Hydrologyof the Alboran Sea

The Mediterranean context

The structure and dynamics of the Alboran Seacannot be understood without taking intoaccount the role played by the Mediterranean climate engine. Due to its geographical position and configuration, the Mediterranean basin is subject to a climate regime which imposes water evaporation losses exceed the gains from the amount of rainfall an driver inputs.The excess evaporation determines the operation of the Mediterranean as aconcentration basin and causesa double effect: an increase insalinity (and density) and a water deficit representing about 14 cm every year over the Atlantic determinants water exchange through the Strait of Gibraltar.

Water masses and general circulation

From the Straitsof Gibraltar, the Alboran Seais thefirst basinof the western Mediterranean meet and interact where the Atlantic Ocean and the Mediterranean Sea. It is characterized by a powerful hydrodynamic and by the permanent presence of a layer system consisting of three different layers in terms of temperature and salinity (Fig.2)

The meeting between the masses ofAtlantic and Mediterranean waters in the Alboran basin, with different thermohaline properties is causing a variety of hydrodynamic structures: fronts (geostrophic front of Almeria, Spain - Oran, Algeria), complex behavior fronts (north-western front), large anticyclonic gyres and upwelling phenomena.

These oceanographic and topographic features can characterize and include most distribution models of marine biodiversity and integrate their importance in the design of a network of conservation areas in the marine environment.

Specifically, the surface circulation in the Alboran Sea is characterized by the entry of surface water from the Atlantic (ASW AtlanticSurfaceWater) to 150-200m deepwater with a salinity increases as they head towards the East and mix with original Mediterranean waters, while taking the name changed to Atlantic waters (MAW, Modified AtlanticWater).

Upon entering the Alboran basin, ASW moves to the Northeast to longitude 4° West about when taking a Southeast orientation towards the African continent. At the Cape Three Forks, it splits into two paths: one along the Moroccan coast to the West, representing the southern path of the Western anticyclonicgyre (WAG, Western Alboran Gyre); the other generally leaving the African coast to the north-east and following the dorsal Alboran to finally give birth, through geostrophic balance to another anticyclonicgy relocated in the eastern basin (EAG, Eastern Alboran Gyre). The western gyre is almost constant, although a process of migration and disappearance in the East has been described, while the Eastern gyre appears to have a more sporadic behavior (Fig.3).

Ocean fronts are areas of high primary productivity that concentrate a high biological diversity: they are key elements for the conservation of species.

The modified Atlantic waters (MAW) and Mediterranean waters (MW, Mediterranean Water), which outcrop at the surface along the southeastern coast of Spain, have different densities and form a front that develops on the North course WAG, causing a movement of surface water offshore, offset by upwelling, hot and nutritious.

Another dense front grows on the eastern path of the EAG, the Almeria-Oran front (AOF, Almeria-Oran Front), and separates the MAW Mediterranean Surface Waters (MSW) denser and more salty. These MSW are the result of the mixture of Modified Atlantic Water (MAW) who completed the tour of the Western Mediterranean basin ("old" MAW) and of the Levantine Intermediate Water (LIW). Near Oran, the flow is divided into two paths: one is heading to the West, closing the eastern gyre, and the other to the east along the Algerian coast, forming the Algerian current. The Almeria-Oran front has a primary geostrophic circulation and a secondary cross-frontal circulation.

As indicated above, the entry of surface water from the Atlanticis compensated by a current of Mediterranean water that comes out to the Atlantic Ocean through the Strait of Gibraltar, with two bodies of water (Fig.4):

- Intermediate Levantine waters between 200 and 600m depth, characterized by the highest of the Mediterranean Sea salinity values. They are formed in winter in the Levantine basin of the Eastern Mediterranean and travel to the western basin via the Strait of Sicily.
-The Western Mediterranean Deep Waters (WMDWs), between 600 and the bottom, characterized by the lowest temperatura of the Mediterranean Sea. They are formed in winter in the Gulf of Lion and move parallel to the south-eastern coast of the Iberian peninsula.

Thus, the Alboran Sea is made up of Atlantic surface waters which are generally colder and less saline (15 to 24 ° C and a salinity of about 36.30 per-thousand) than Mediterranean waters further east, with a slight seasonal variation coast to offshore, coastal waters being a little saltier.

The hydrodynamics in the Alboran Sea (composed of fronts and upwellings) also helps explain the comparatively high productivity of the sea. The water basin characteristics make the waters are richer with levels of Phytoplankton biomass and biological productivity superior to other parts of the Mediterranean (Fig. 5). The northwestern zone of upwelling and the geostrophic fronts are places where the availability of nutrients for phytoplankton is important: they contrast sharply with areas of low

productivity, where oligotrophic anticyclonic gyres are located (Fig. 6). This wealth is remarkable because the Alboran basin is characterized by the absence of large riverine inputs.

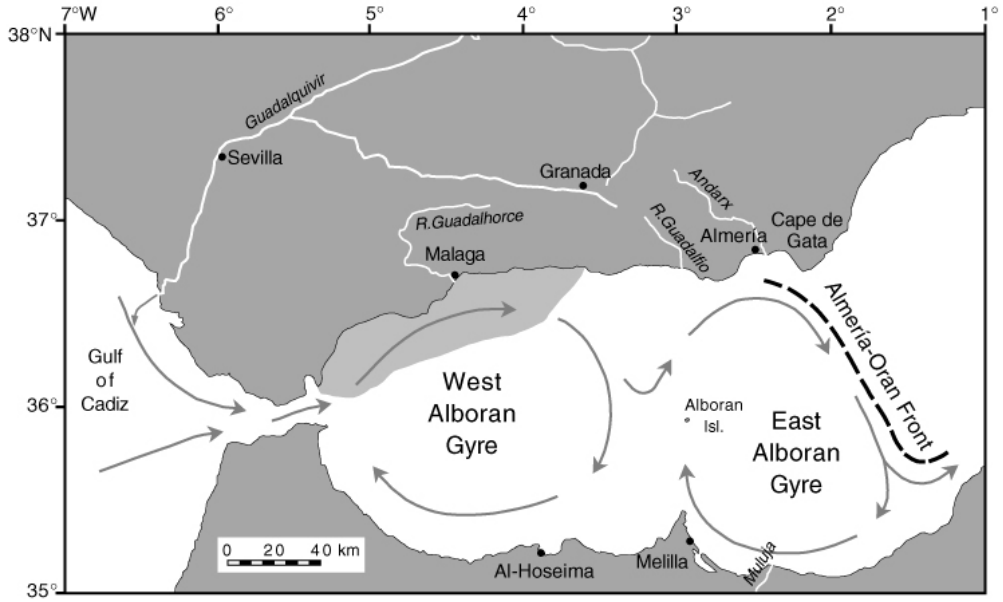


Fig. 2. Outline of the major oceanographyc events in the Alboran Sea, highlighting the two anticyclonic eddies formed by the entering Atlantic waters. Source: www.eoearth.org/view/article/149961

1.2. Geomorphology and geodiversity of theAlboran basin

The geology and geomorphology of the Mediterranean basin are very varied and are formed of interlocking parts.Two major regional features stand out: the Eastern Mediterranean and the Western Mediterranean basin, separated by the Strait of Sicily. In the western Mediterranean basin, there are other smaller subunits: theAlboran basin, theAlgerian-Balearic Basin, the Provençal basin, etc., which are distinguished from each other by their geomorphological and strutural features.

The north and southboundaries of theAlboran basin are defined by the continental margins of Europe and Africa. In the West, the boundary corresponds to tall structures (threshold) that dominate the bottom of the Strait of Gibraltar and to the East, the clear separation between the Alboran Basin and the Algerian-Balearic Basin. Schematically, one can distinguish three sub-basins (western, eastern and southern); a ridge oriented SW-NE on which Alboran Island is located (also called dorsal Alboran); and several volcanic seamounts divided between the two continental marginsand that are either grouped or aligned along small ridges (Fig.7).

The western basin of the Alboran Sea

The western basin of the Alboran Sea is connected to the Atlantic through the Gibraltar Strait channel which is the inputof imported surface water of the Atlantic, and the output of deep water exported by the Mediterranean Sea. The abyssal plain reaches a máximum depth of about1400meters. The two most important physiographic features of this sub-basin are the canyons and sea mounts (Fig. 8).

Many submarine canyons are concentrated in the vicinity of the Strait of Gibraltar from Algeciras Canyon, the canyon of the Línea (with two very distinct heads) and the canyon of

Ceuta. Further east, the canyons of Guadiaro, Calahonda, Fuengirola and Guadalmina are located on the northern slope of the western basin.

In some cases (such as Guadiaro and Fuengirola), there is a large deltaic cone associated to the canyon. On the southernslope, one can distinguish the Xauenbank, the channel of the Strait of Gibraltar and the Ceuta Canyon through which passes most of the sediments that are deposited in the deepest part of the Alboran Basin.

A slightly inclined to the south-east plain stretches between the two slopes. It is dotted with some relief, as Ibn Battutabench-volcanic ("Vizconde de EzadelBench" according to some authors), and other structures such as mud volcanoes or hydrocarbon fluid expulsión phenomena.

To the east, we find the western basin bounded by the marginal shelf of Motril-Djibouti. This elevation is formed by a group of seamounts that makes up the entire Djibouti bank: these are the Banks of Herradura (also called "Mount Djibouti"), Mount ElIdrisi (or "Bank CityDjibouti") and the MountAvempace (or"Algarrobo"for the fishing fleet) on the continental slope, closer to the coast. The deltaic systems of the canyons of Motril and Sacratif and several structures reflecting the geological instability as the grabben of Baraza or the collapse of Blogs and the gully of Almuñécar, are present on marginal shelf of the northernslope.

This group of mountains is bounded on the south by the Alboran Channel, which separates the South Iberian margin of the dorsal Alboran itself. These mountains are part of the elevated structure of the channel separated by a small cliff that ends at North with the dorsal Adra (also called "peak Averroes"), itself formed by a succession of small volcanic mounds very fractured and offset from each other by NNW-SSE trending faults. This set allows sediment to accumulate, forming what is called Ceuta deposits.

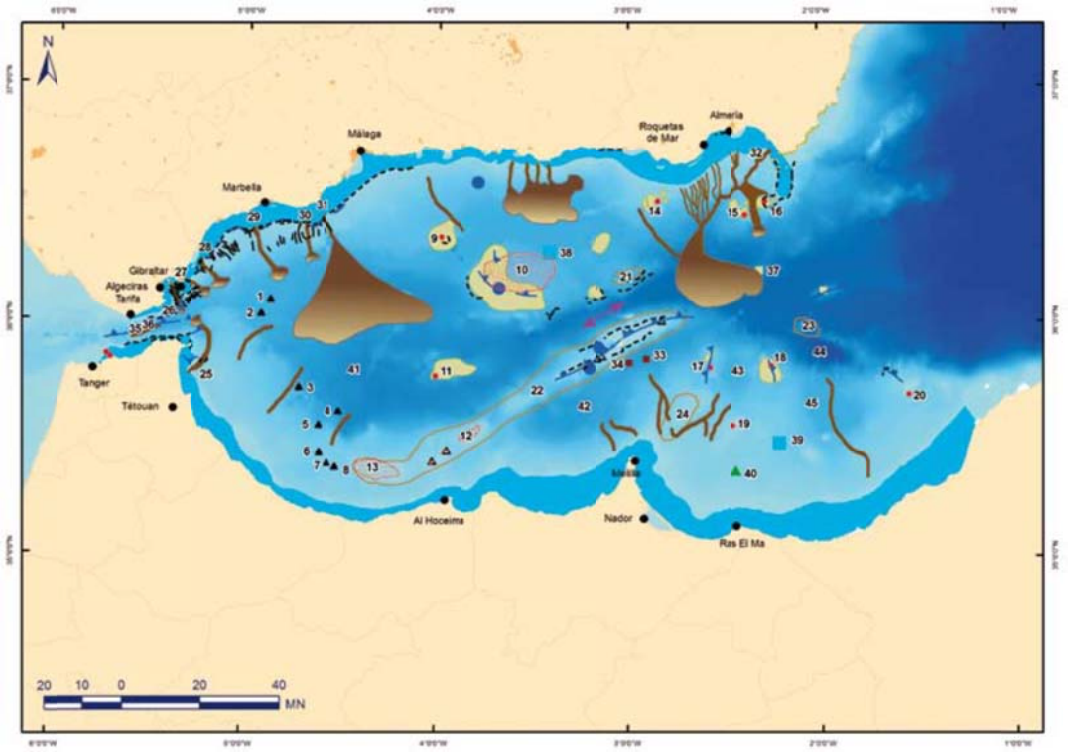
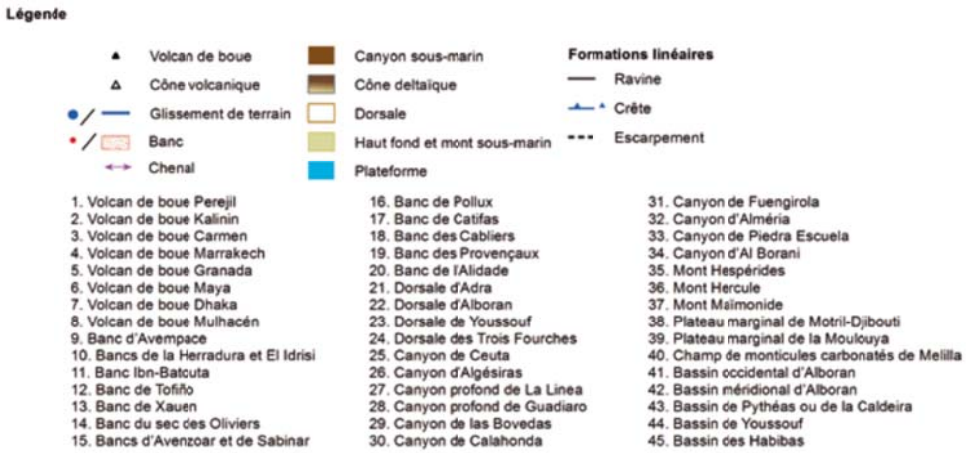


Figure: geomorphological characteristics of the Alboran Sea



The eastern basin of the Alboran Sea

It stretches east to the Algerian-Balearic Basin reaching a depth of 1,800m. It is connected to the western basin by the Alboran channel and extends continuously up to the transition zone with the South Balearic basin. Between the two lines, as in the case of the western basin, a slightly inclined to the east plain is separated in two by the Alto Al-Mansour. The depths of the funds vary between 1,800 and 2,400 meters, and the northern and southern boundaries are respectively the north-eastern margin of Alboran and the Youssouf-Habibas system.

These continental margins delimiting it are characterized by very rugged terrain with, again, canyons and seamounts marked by steep escarpments in the North African margin (Fig. 9).

On the Iberian continental margin, some submarine canyons and numerous erosion furrows and gullies are present, some of them related to the phenomena of destabilization of slopes. We meet the canyon of Almeria which stretches about 55 km and the gully of the Campo ded Dalías. Also, in this part of the margin, seamounts of volcanic origin are observed, isolated and near the continental shelf so facing the Campo de Dalias, the massif of Chella (Seco de los Olivos). At its peak some coral communities havebeen observed with*Lophelia pertusa*, a rare and important ecological formation. To the east, along the SW-NE direction, in the immediate vicinity of the Gulf of Almeria, the banks of Sabinar and Pollux are located on a high structure delineating, to the south, the underwater canyon of Almeria.

Finally, south of the promontory of the Cape of Gata, the beginning of the peak of Maimonides (or Los Genoveses) develops further in theWSW-ENE direction towards the South Balearic basin.

On the North African continental margin which forms the southern boundary of the sub-basin, there is the vast marginal plateau of the Moulouya River, over which the banks of Provence and Cabliers are emerging. Youssouf basin is the closest of the continental margin depression, wedged between the crest of Youssouf and the escarpment of Youssouf-Habibas.

To the mainland of Africa, there is a relatively flatten area crowned witht wo dorsal, Catifas (or Caldera) and Cabliers, which confine the Pythéas basin (or Caldeira). In the extreme southeast of the vast Algerian-Moroccan marginal plateau is the bank of the Alidade, which marks the most significant relief of the eastern boundary of the Alboran basin around the city of Oran.

The southern basin (Almohades) of the Alboran Sea

Of slightly smaller dimensions, the southern basin is elongate in the SW-NE direction and located between the dorsal of Alboran and the marginal plate of Moulouya. To the south of this basin is the basin of Al Hoceima, active fracture zone due to the moderate to high seismicity of the area. South of the southern Alboran Basin and east of the city of Nador, an important site of carbonate mounds, known as the "field of carbonate mounds Melilla" was recently located at depths ranging from 250 to 450 m. It is formed by bio-constructions of ancient reefs of cold deep water. These mounds can be up to 150 m high peaks form up to about 6 km long.

The dorsal Alboran

This is a salient structure, both homogeneous and continuous, extending from the North African margin, through the Alboran Sea along the SW-NE direction, and ending abruptly NE of the island of Alboran.

This ridge is divided by faults oriented ENE-WSW at E-Wterraced into two segments: the banks of Tofiño and Xauen (south-west) and the bank of the Alboran Island (North-East). It extends over a length of 180km between Xauen bank in the southwest and the escarpment of Youssouf in the Northeast and, in the North African margin, it separates the western basin and the central cannel Alboran in the north from the southern Alboran basin in the south. At the level of the bank of the Alboran Island, the powerful hydrodynamism of the Atlantic current promotes the installation of high biodiversity.

On the opposite side of the island of Alboran, many landslides occur, such as the avalanche of Bolos, located along the canyon AlBorani which moves a large amount of material from the upper part of the dorsal to the deep basin.

2. Identification of specific natural features in the marine environment of the Alboran Sea

In order to correctly the biodiversity of the Alboran Sea, units and conservation elements were selected at different geographical scales. Among them were the communities and species both marine and coastal habitats and ecological processes.The sources used to define these elements have resulted from available information and from consultation with specialists.Thus, it was possible to identify in particular, as a conservation elements for the Alboran Sea, priority species and special ecological communities of fish stocks and their breeding sites, archaeological zones, coastal wetlands, areas with cetaceans, important areas for birds and flora and fauna communities associated with deep bottoms.

Their selection meets the criteria adopted by the experts (see final section of this report) who helped define each of these elements in different evaluations for analysis ofimportant sites for marine biodiversity conservation while taking into account the pressures and threats.

2.1. Biodiversityof benthic fauna

As a transition zone between the Atlantic Ocean and the Mediterranean Sea, the Alboran Sea is a frameworkof special interest, with different affinities to the benthic fauna, particularly Atlantic and Mediterranean.

Experts have said the initial criteria on benthic habitats and species to define the sites selected by considering the following:
-The diversity of habitats and microhabitats.
-Species richness.
-The coexistence of species from different biogeographical origins as the couples *Gibbulaarilineata* and *G.pennanti*; *Patellaintermedia*and *P.caerulea*; P. *ferruginea* and *P.aspera*.
-The breeding and rearing (permanent or temporary) of harvested species as *Merluccius merluccius, Xiphiasgladius, Aristeus antennatus or Parapenaeuslongirostris*.
-Short-stay áreas of migratory species.
-Habitats that, due to their relationship with geomorphological characteristics or because of biological communities they host, occupy minimal áreas in the Alboran Sea, for example biological communities that occupy some submarine canyons with geological activity or head lands or underwater mountains.

Regarding species, the following section details different categories considered as important.

2.2. Protected species

First, it should take into account all the protected species on the Red List of IUCN, and in particular those appearingin Annexes II and III of the Barcelona Convention and species listed at national or regional level in the under other instruments. We will pay particular attention to populations of species that have suffered significant mortality in recent years, which are rare, such as the red oyster *Spondylusgaederopus,* or populations that have strengthened or are in development and could recolonize other parts of the Alboran sea and play a role in the dissemination of larvae, which would be the case for the *Patella ferruginea* around Chafarinas islands (Ya`fariyya), Habibas Islands and in other sites on the coast of North Africa.

2.3. Bio-constructing Species

The bio-constructions are important because they shape the environment and communities; they therefore constitute a support and a habitat for many other species. In the Alboran Sea, encountered in particular:

- Vermetid reefs (gastropods) associated with calcareous algae, often *Dendropoma petraeum* but also in some sites *Vermetus triquetrus*.
- Coral colonies of *Cladocora caespitosa*, which in some sites, may constitute pseudo-reef formations.
- Bottoms covered by yellow coral *Dendrophyllia ramea* and *D. cornigera*.
- Deep white coral bottoms, with *Lophelia pertusa* and mainly Madrepora oculata, which may constitute true deep coral reefs.
- Concretions by bryozoans *Pentapora fascialis* and *Myriapora truncata*.
- The gorgonian species *Paramuricea clavata, Eunicella singularis, Eunicella verrucosa, Eunicella gazella, Leptogorgia sarmentosa, Leptogorgia lusitanica, Ellisella paraplexauroides, Callogorgia verticillata*.
- The red coral colonies of *Corallium rubrum*.
- The orange coral colonies of *Astroides calicularis*.
- The giant oyster beds *Neopycnodonte zibrowii*.
- The bottom crinoids *Leptometra celtica*.
- Deep water sponges.
- The black corals.

2.4. Endemic species or with restricted distribution

Species are considered as endemic, rare, vulnerable or endangered when they are not of economic interest, and species with planktonic larval phase with a very low dispersion capacity, disappearing forever when they are removed from their preferred site, unless being artificially reintroduced. In Alboran Sea, in the case of the starfish *Asterina gibbosa*, the slipper lobsters *Scyllarides latus* and *S. arctus*, the gastropod *Fasciolaria lignaria* or endemic species of the Strait of Gibraltar such as *Petrosia raphida, Bubaropsis alborani, Gellius bioxeata, Halicometes elongata* and *Histodermion cryosi*.

2.5. Rare or very rare species

In this category, it will be considered rare, in general or in particular in the Alboran Sea, species which has a low number of individuals in the entire Mediterranean region as *Velolambrus expasus, Euchirograpsus liguricus, Neopycnodonte zibrowii, Pilumnus inermis, Parvicardium vroomi, Spirolaxis centrifuga, Asbestopluma hypogea* and *Anachis aliceae*.

2.6. Species threatened by fishing effort

Species like shark *Prionace glauca* or crustaceans *Majabrachydactyla* and *M.squinado* are concerned.

2.7. Species of mega fauna (mammals and turtles) and seabirds

Marine mammals

Hereafter is the summary of the specific report prepared for the purpose of MedOpenSeas activity. *Cañadas A., Gauffier P., Gimenez J., Jimenez Torres C., Verborgh P., Esteban R., García Tiscar S., García Moreno P., Aguilar A., Raga J.A.,Castellote M., Rendell L., Brotons, T., Vázquez J.A. and de Stephanis R. 2013. Alboran Sea: 1. Status of Cetaceans.MoU N° 07/RAC-SPA/2013/MedOpenSeas*

Many individuals of marine mammals are present in the Alboran Sea each year as they find a favorable site for feeding, reproduction or shelter. The common species of marine mammals are the killer whale *Orcinus orca* (often presenting the Strait of Gibraltar near the traps where the bluefin tuna is concentrated), species *Balaenopteraphysalus, Physetercatodon, Globicephalamelaena, Ziphiuscavirostris, Phocoenaphocoena, Delphinus delphis, Stenellacoeruleoalba* and *Tursiops truncatus*.

The major threats to cetaceans in the Mediterranean ingeneral and int the Alboran sea in particular are linked with the fishing industry(Overfishing-Bycatch-Direct takes- Competition for resource- Collisions with ships- Dynamite fishing), the degradation of habitat, the maritime traffic, acoustic disturbance, pollution and disease and tourism and whale-watching.

Fishing Industry (Overfishing-Bycatch-Direct takes- Competition for resource- Collisions with ships- Dynamite fishing)

One of the most important threats facing cetacean species in the past was the direct driving fishery industry developed over last century in the Black Sea (Reeves and Notarbartolo, 2006). Nowadays cetacean threats with this industry, includes most notably the conflicts with fishermen for food resources and the incidental capture on fishing gear.

Fishing has increased considerably in the Mediterranean region since the 70s and the fishing fleets had (and continue to) increase in number and technological efficiency. The fleet expansion had been consequently translated into greater fishing effort and heavier exploitation of fish stocks.

Fisheries by-catch, is considered to be a major problem and is the major source of human-induced mortality of cetaceans. Entanglement in fishing gear like bottom and pelagic longlines, drift and bottom gillnets and trawlers, are a common cause of drown and death of harbour porpoises and other cetaceans that frequent coasts and heavy commercial fishing zones. The unregulated fishing activities in the area may contribute significantly to these mortalities.

Direct catches and collision with fishing vessels are other important causes of concern to the decline of the marine mammals populations.

Dynamite fishing still occurs in some Mediterranean waters and although strictly prohibited by the governments, is practice regularly in some areas causing extensive damage to rocky bottoms and coastal seagrass beds. This illegal activity has been reported to directly inhibit the normal feeding behaviour of the bottlenose dolphin in Lebanese waters (Evans, 1987) and caused injures and kills of monk seals in Western and Southern Mediterranean Sea (Tudela, 2004).

Other threats like the impact that lost or discarded fishing nets in coastal waters have on the cetaceans are unknown.

Degradation of habitat
A more generalist concern is that habitat loss and degradation may have a substantial impact on coastal cetaceans and other marine mammals. Coastal development might destroy fish nurseries, decrease water quality and help propagate invasive species. The mechanical destruction of the sea bottom caused by the large number of trawlers impacts seagrass beds and other marine habitats by both suspending sediments and directly damaging the prey of cetaceans. This is believed one of the main reasons to affect fish recruitment and the quality of juvenile feeding areas in the Mediterranean Spanish coast (Sánchez-Jerez and Ramos-Espla, 1996).

Maritime traffic, Acoustic disturbance
Normal ship traffic causes death due to collisions and propeller injuries. Noise from marine ship traffic, military exercises (sonar, detonations), coastal industry and research using sound, oil and gas exploration and extraction, are believed to cause varying levels of disruption to normal cetacean activity (Parson *et al*., 2009).

Pollution and Disease
The increasing amounts of plastic debris at sea, oil spills and dump of industrial wastes into waterways and the sea many times without or inadequate waste water treatment constitutes a serious problem for the marine environment.

Coastal tourism and whale-watching
One of the major threats to coastal ecosystems and therefore, the species that inhabit or partially depend on them, is the uncontrolled and unplanned coastal development. Over the last years, the pressure due to coastal tourist development has increased exponentially, especially along the northern and western margin of the Mediterranean basin. This pressure intensifies in certain localities and coasts where the population increases by two to three folds over the summer period. The increase on coastal urbanization results in excessive sediment loads and eutrophication of the coastal waters affecting furthermore areas already under man-made stress. Whale watching is one major attraction of the Alboran Sea, mainly in the strait of Gibraltar, adding, when not practiced correctly to the other disturbances such as maritime traffic.

Proposed conservation measures

The future of marine mammals will be determined by our current and future actions. The Mediterranean basin should be the unit for management marine and coastal resources. This approach will allow looking for a range of solutions to help the declining populations of marine mammals. The emphasis should be to improve our existing knowledge and created a more integrated approach to Mediterranean endangered species and its environment. Thus, recommendations on conservation measures follow a general view in order to construct a better framework:

1. Identification of hot-spot for different species of cetaceans
2. Establish new marine sanctuaries and conservation measures that cover the range of resident or frequently visited sites
3. Control of pollution and monitoring of cetacean populations to assess trends and geographical variations of pollutants in tissue levels
4. Abundance should be regularly monitored to assess changes through the time and identify potential problems well in advance
5. National protection status with specific protections to species endangered
6. Identification and implementation of specific measures: area-season, fishery-specific reductions in fishing effort, curtailment of inputs of particular pollutants
7. Development of a comprehensive outreach and education strategy to promote responsible viewing of wild mammals by tourists and commercial operators

Cetaceans Research actions required

1. More surveys on the entire basin should be carried out covering those areas with limited or no data (i.e. southern Mediterranean Sea) to estimate distribution, population structure and abundances
2. Genetic and/or molecular analysis need to be perform to discern taxonomic and sub population structure differences and similarities within the Mediterranean
3. Enhance the effort to document mortality (direct or incidental) due to fishing activities
4. Diet should be studied to assess overlap with commercial fisheries

Proposed sites for conservation in the Alboran Sea

Based on the existing data, the experts are recognising the overall importance of the Alboran sea for the cetaceans. Nevertheless, if some specific sites could be proposed for conservation action, the Alboran Island area and the Strait of Gibraltar (north and south) are the top priority. In addition along the sites, multiple sites have been identified with the presence of groups of cetaceans, regularly all over the year, indicating the importance of these sites for their survival, but they are difficult to delineate and subject to modification with increasing climate change effects on the marine environment.

Mediterranean monk seal

TheMediterranean monk seal*Monachusmonachus*, a species highly endangered, is also observedsporadicallyinthe area fromOrantoAl Hoceima,butwenowassumethat he probablydisappeared from this areaand thatonly erratic individualsare encountered.

Marine turtles

As there is no nesting beach in the area of the alboran Sea, there is limited information about marine turtles, most fo them being present in the area for migrating or feeding. For example, the loggerhead seaturtle *Caretta caretta*uses the Alboran Seaas a transit zonefrom the Atlanticto itsnestingareas ineastern andsouthern Mediterranean.

Marine birds

Hereafter is the summary of the report prepared for the purpose of the MedOpenSeas activity by SEO Birdlife (*Arcos P. & Orueta J., 2014. Alboran Sea: Status of marne birds. SEO-Birdlife, Spain.MoU N° 07/RAC-SPA/2013/MedOpenSeas)*

The Alboran Sea represents a transition area between two major oceanic basins, the Atlantic and the Mediterranean, which deserves particular attention for its high biodiversity and relatively high productivity. The open seas have received particularly little attention, and an MPA approach is mandatory, to be combined with other conservation tools.

Seabirds are not exception, and the local seabird community is notoriously diverse, influenced by both the Atlantic and the Mediterranean basins. About 25 seabird taxa are regular in the region, whereas several others occur there on an irregular basis or accidentally. Despite the relevance of the region for seabirds, breeding populations are rather small and restricted to a few suitable nesting sites, although some potential areas remain poorly prospected and deserve future attention. Regarding the most pelagic species, the Alboran Sea also attracts breeding birds from colonies outside the region, particularly shearwaters. One of the key roles of the region is as the unique migration corridor between the Atlantic and the Mediterranean. Hundreds of thousands of seabirds of several species cross the area regularly to migrate between these two basins.

Information regarding seabirds in the Alboran Sea is patchy and requires of further research, particularly on the African side. This includes information on seabird breeding populations, as well as on distribution patterns at sea. But it is also necessary to improve the knowledge on human activities and their potential impact on seabirds. Information (and conservation action) regarding predation by introduced mammals in the colonies, and fisheries bycatch at sea, deserve particular attention. It should be notedthat, the most important species from a conservation point of view are the Audouin's gull *Larusaudouinii*, the osprey *Pandionhaliaetus*, the Cory's shearwater *Calonectris diomedea* and the cormorant Phalacrocor axaristotelis.

The prioritization of marine protected areas for seabirds in the Alboran Sea should take into account which the main values of the region for this group of birds are. As described in this document, these include breeding sites (wetlands and islands), migration hotspots and foraging areas for breeding, migrating and wintering birds. These values point to different key areas to be protected. Current conservation action at international, regional and national level is already addressing these needs.

Alboran region marine birds priorities

The following actions should be considered as prioritary to improve the knowledge on seabirds and to address their conservation in the Alboran Sea:

1. *Monitoring of seabird colonies.* There are relatively few known seabird colonies in the Alboran Sea, but there is potential for new sites, particularly along the African coast. Assessing breeding seabird numbers is mandatory, which includes sound counts of the known colonies (to be maintained on a regular basis), as well as surveying for potential new colonies. A few colonies of reference should be taken for a more detailed monitoring, which allowed to assess demographic parameters and hence assess population trends. Shearwaters and the European storm-petrel deserve particular attention.
2. *Monitoring at sea distribution.* Information on spatiotemporal distribution patterns at sea is key to understand the role of seabirds in the Alboran Sea, assess potential threats and address their conservation. A combination of boat-based surveys and remote tracking is recommended to optimise results. The African coast deserves particular

attention, as well as the most pelagic regions of the Alboran Sea, as fewer studies have been conducted there.

3. *Assessment of threats.* Efforts to properly assess the main threats that seabirds face in the Alboran Sea are necessary to ultimately improve their conservation status. Particular attention deserved the monitoring of predation at colonies and of fisheries bycatch at sea (observer's programmes, questionnaires). Small artisanal vessels, particularly longliners, should receive particular attention regarding bycatch, as they can have a major impact on the shearwaters.
4. *Identification, designation of Marine Protected Areas (MPAs).*The most relevant marine hotspots for seabirds have been already been identified, although further work is necessary to complete the current picture. A combination of further work to identify new hotspots (related to point 2) and policy work to designate the known ones is necessary. Particular attention deserved the open seas, where jurisdiction might be shared by different countries, and international agreements are necessary. Specifically, and given its relevance as a migration hotspot at regional and even global level, it is necessary to find the best formula to provide protection to the Straits of Gibraltar.
5. *Implementing management plans for the MPAs.* So far a few seabird hotspots have been already designated, and other are already identified and pending the best formula for their designation. Providing actual protection for these sites is mandatory, through the implementation of appropriate management plans. This way, seabirds will receive effective protection at least in their main hotspots. This would also provide protection to other marine organisms within these hotspots (umbrella effect). On the other hand, conservation work developed in these sites could be also a model to implement wider regional conservation measures.
6. *Conservation action beyond the MPAs.* The MPA approach is a promising tool for conservation, but complementary work is necessary to properly address seabird conservation, and ultimately the conservation of the Alboran Sea marine ecosystems. This includes addressing regional regulation of activities, as well as implementing species' action plans that help improving the status of the most threatened seabirds.
7. *Communication and dissemination with stakeholders and the general public.*For any conservation measure to be successful, it is mandatory to properly communicate the conservation problems of the region to the stakeholders and the general public, and to involve them in any conservation action. They must understand that working towards the conservation of the marine environment is equivalent to ensure their future income, particularly for wide implemented practices such as fishing.
8. *Improve cooperation between countries*. As stated above, international cooperation is mandatory to properly address the conservation of the Alboran Sea region, as this is a small basin surrounded by different countries.

Threats to marine birds

The threats to birds can be on land or at sea. Inland, it is mainly the predation by invasive species and the growth of coastal development

- Predation by rats has been described in the Chafarinas archipelago as a factor negatively influencing the breeding performance of Cory's shearwaters (Igual et al. 2005, 2007, 2009), whereas the effect on gulls seems marginal (Prieto et al. 2003). Moreover, smaller Procellariiforms such as the European storm-petrel and the Yelkouan shearwater could be prevented of breeding there due to the presence of rats, and the same is likely in other potentially suitable areas along the African coastline.
- The increasing humanisation of the coastline, including urban development, infrastructures, light pollution and disturbance, poses a threat to seabirds, particularly on their breeding grounds. This likely affects both coasts of the Alboran Sea, and is particularly relevant for gulls and terns breeding in wetlands, as these habitats have been severely affected by human activities.

At sea, fisheries bycatch, fishing overexploitation, pollution and marine infrastructures are the main threats.

- Seabird bycatch in fishing gear is one of the most serious threats to many seabird species, including some of the most common seabirds in the Alboran Sea (e.g. Cory's and Balearic shearwaters). However, the available evidence is very limited for the region (Arcos et al. 2012b). Only pelagic longlines have been monitored to some degree (García-Barcelona et al. 2010 a,b), reporting very low bycatch rates in the region. On the other hand, reports from beached bird surveys suggest that demersal longlines, nets and pole lines could have some impacts on seabirds (García-Barcelona et al. 2010c). Further research is necessary to properly assess the incidence of bycatch in the Alboran Sea, as high levels have been described in neighbouring areas of the Mediterranean Sea.
- The Alboran Sea holds an important fishery for small-pelagic fish species, mainly sardine and anchovy, which has undergone severe fluctuations and is likely overexploited (Copemed II. 2011). Since these are the main natural prey for most seabird species, keeping severe exploitation without proper assessment and management could cause impact on the seabird populations, both breeders and non-breeders (e.g. Louzao et al. 2006a, Cury et al. 2011).
- Both background and acute-events pollution pose a serious threat to seabirds worldwide, and the Alboran Sea is no exception. Of particular relevance is the risk of acute events of pollution such as oil spills, since the Alboran Sea holds one of the busiest maritime routes of the world (Sánchez de Vivero 2013), thus raising the likelihood of accidents and other impacts on marine biodiversity (Abdulla & Linden 2008). Background pollution includes potential impacts from plastic ingestion (Arcos et al. 2012b).
- Development of infrastructures at sea could pose a risk to seabirds. Within the context of the Alboran Sea, windfarms pose a particular threat given the relevance of the region for migrating seabirds (i.e. intense flow of seabirds prone to colliding with these infrastructures). So far the area includes a few proposals of wind-farm development, all of them in the Straits of Gibraltar area (Sánchez de Vivero 2013), where the risk to seabirds would be highest.

Proposal for the designation of SPAs for birds in the Alboran Sea (see next figure)

Three areas have been designated by Spain:

- Almería Bay. This is a relatively productive area within the Alboran Sea context, holding important populations of small pelagic fish. The area is good as extension to colonies of breeding gulls (particularly slender-billed gull, 225 breeding pairs) and terns (common and little terns). Audouin's gull also concentrates in the coastal wetlands outside the breeding season, and make extensive use of the marine environment. Finally, the marine area is a typical foraging ground for the Balearic shearwater, with hundreds of birds regularly in autumn and winter (up to over 2000 birds).
- Malaga Bay – Cerro Gordo. This is the other area with relatively wide continental shelf in the northern coast of the Alboran Sea, and with relatively high productivity, also holding important populations of small pelagic fish. Balearic shearwaters gather there in their migration routes, often hundreds, as well as several other seabird species. However, the most relevant species is the Mediterranean gull, which finds here its second largest wintering area in the Mediterranean, with up to over 20,000 birds in late winter.
- Alboran Island marine area. The area is proposed mainly as an extension to the breeding colony of Audouin's gull, one of the historical strongholds of the species, with over 500 breeding pairs at present.

Other areas are considered as important on the southern coast of the Alboran Sea, in addition to the strait of Gibraltar, and in particular the area of the Moulouya river mouth, the area from east

Moulouya to the Cape Trois Fourches and the area from this cape to the western part of Al Hoceima National Park with an important nesting population of ospreys.

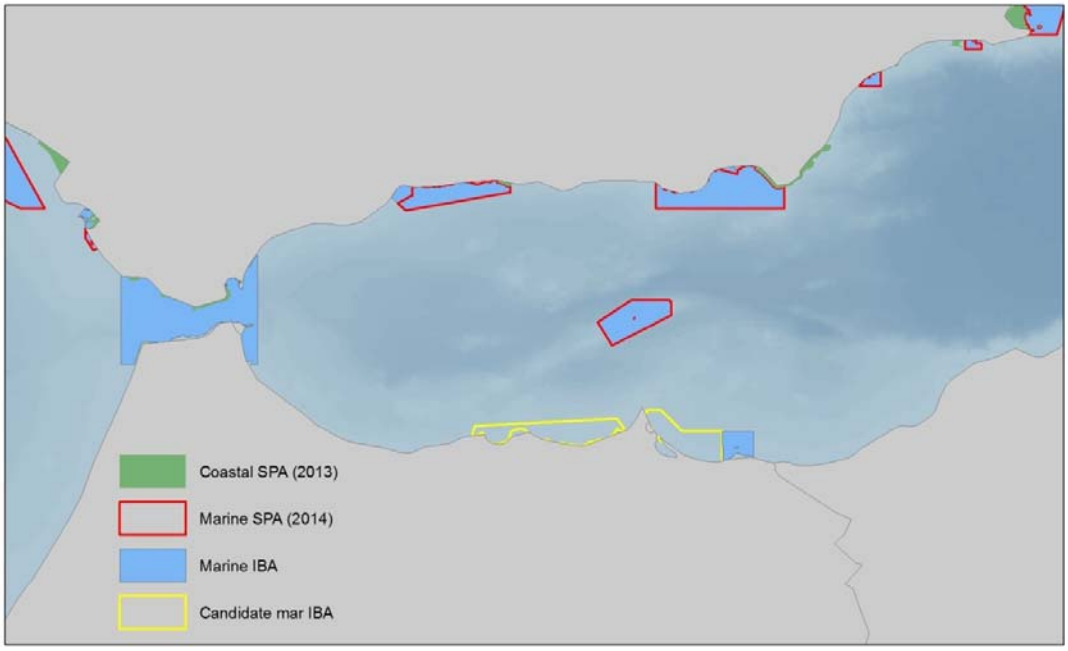


*Figure:*Spanish recent proposal of SPAs in the Alboran Sea region (red lines), as well as marine IBAs identified by SEO/BirdLife in Spain (blue areas) and potential IBAs outside Spanish territory also proposed by SEO/BirdLife in 2009 (yellow lines).

2.8.Biological diversity of marine flora

Regarding marine flora, only macro-algae and marine angiosperm are considered for selection and planning of protected areas. These communities have a special importance as a place of spawning, feeding or residence for many marine wildlife species.The experts considered that it was necessary to focus on the benthic marine flora taking into account the species of conservation interest.

Species retained within this framework are as follow:

Seagrass
Cymodocea nodosa, Posidonia oceanica, Zostera marina, Zostera noltii
Genus*Cystoseira*
Cystoseira balearica Cystoseira compressa, Cystoseira elegans, Cystoseira foeniculacea, Cystoseira mediterranea, Cystoseira nodicaulis, Cystoseira sauvageana, Cystoseira spinosa, Cystoseira stricta, Cystoseira tamariscifolia, Cystoseira usneoides, Cystoseira zosteroides.
Laminaria
Laminaria ochroleuca, Phyllariopsis brevipes, Phyllariopsis purpurascens, Saccorhiza polyschides.
Species *Rissoella verruculosa*
Red calcareous algae (and maërl)
Genus *Lithothamnion, Lithophyllum, Spongites, Mesophyllum, Peyssonnelia* and *Phymatolithon* and the species *Neogoniolithon mamillosum*

To facilitate the understanding and development of marine life indicators, the species targeted by this study were grouped into 5 categories. The peculiarities of some species within each category are detailed below (see Tables 4 and 5).

The two main criteria considered for the benthic fauna are:

- Species sensitive to habitat alteration: the taxa whose characteristic hábitat is particularly threatened, in sharp decline, Split or very limited.

- Vulnerable species: taxa that might move to the previous category in the near future if current threat factors are not corrected.

2.9. Non-native, introduced and invasive species

Although biological invasions, Alboran Sea may be part of a natural process of dispersal and of colonization of new habitats, especially by species from the Atlantic, there was an increase in recent years and a dispersion of non-native marine species in the region.

However, despite the magnitude and severity of this problem, research is insufficient and the limited data available (coming primarily from studies conducted on the north bank of the Alboran Sea) indicate the presence and colonization of some ecosystems by several species of this type.

The blue spotted cornetfish (*Fistularia commersonii*) repeatedly reported in the Alboran Sea, is of Indo-Pacific origin and was introduced in the Mediterranean through the Suez Canal. This fish is considered one of the 100 species at risk of becoming invasive in the Alboran Sea, because of its high level of reproduction and rapid growth. Among the non-native fish species observed on the north shore of the Alboran Sea, the experts have identified the Blunthead puffer (*Sphoeroides pachygaster*), the Silvery John dory (*Zenopsis conchifera*), Spiny scorpionfish (*Trachyscorpia cristulata echinata*) Senegal seabream (*Diplodus bellottii*), the Lusitanian sole (*Microchirus boscanion*) and the Guinean burrfish (*Chilomycterus mauretanicus spinosus*). Among the most invasive species of concern include the macroalgae *Caulerpa racemosa var. cylindracea* that is found in the East of Almeria and in the region of Beni Saf in Algeria and whose capacity for colonization is very high. Similarly, two other macroalgae (*Asparagopsis armata* and *A. taxiformis*) also spread rapidly in the region of Almeria to Cadiz.

Among non-native and invasive species ofmarine macro-invertebrates, we should mention the appearance of Sally Light-foot crabs (*Percnon gibbesi*), the tubular polychaete Australian tubeworm (*Ficopomatus enigmaticus*) forming huge conglomerates constituting reef, the sea anemone *Haliplanella lineata* whose home región is the Pacific, the gastropod *Marginella glabellarecently observed in fishing ports, the chitón (Chaetopleura angulata), the cnidarian Oculinapatagonica* from the South-American coast South, introduced species in aquaculture such as the shrimp *Penaeus japonicus* or molluscs *Crassostrea gigas*, *C. angulata*, *Pintacda martensis* or *Ruditapes philippinarum*. Some of these species were observed in the Nador lagoon and estuary of Moulouya in Morocco.

Migration and installation of these species or other non-native species may be favoured by climate change.

3. The impact of climate change

Global warming and climate change resulting from the continued increase in air emissions, especially greenhouse gas emissions, are in the process of generating changes in the temperature of sea water, variations in the structure of ocean currents and movements, acidification of sea water (resulting in a decrease in the pH of seawater) and therefore to have an impact on marine ecosystems and resources.

In the Alboran Sea, a marked increase in air temperature has been observed since the 1970s, with an average of 0.040 ± 0.023 ° C / year. This increase is of the same magnitude as that observed in the Western Mediterranean (0.4-0.9 ° C). Meanwhile, the temperature of the sea surface has increased by 0.12 ± 0.09 ° C / year in recent decades and increases were observed, although with some fluctuations along the entire column water up to 1 400-2 000 m depth.

The monitoring stations located on the coast of Malaga (Andalusia) indicate that, even if the sea level did not change over the period 1943 to 1990, a trend of increase was recorded from the beginning of 1990 with a rise in sea level of 8.7millimeters per year and an average growth rate between 1943 and 2007 of 1.4mm / year. An increase could also be observed regarding the salinity of medium and deep layers (from 200 m depth).

All these changes can alter the oceanographic processes of the Alboran Sea and result in different effects: a reduction in the intensity of upwellings, of fronts and currents; a decrease in the supply of nutrients to the photic layer; a decline in productive capacity (primary productivity); a reduction in the CO2 absorption rate; and thus have impacts on communities of flora and fauna, species distribution, the physiological response and vulnerability of marine ecosystems and socio-economic activities in the maritime domain.

Areas such as the delta of the Moulouya and the lagoon of Nador in Morocco are clearly vulnerable to floods and rising level of the sea. These impacts can be further aggravated by the absence or weakness of policies and strategies adaptation, such as measures to improve the management of coastal areas.

MPA networks must be designed to preserve the natural state of ecosystems and withstand external impacts, particularly in the case of changes on a large scale and long term as climate change.

4. Socio-economic characteristics, pressures and impacts on marine biodiversity

This section contains precise and certain items presented in the book prepared by IUCN in 2010 on the Conservationand Sustainable Development of the Alboran Sea. For the fishing sector, more elements are available in the specific report prepared within the framework of the RAC/SPA activity concerning Alboran (*Báez Barrionuevo J. C., 2013. Alboran Sea: 3 Status of open seas fisheries. Instituto Español de Oceanografía, Centro Oceanográfico de Málaga)*

4.1. Fishing

Due to the oceanographic and biogeographic singularity of the Alboran Sea, there is great biodiversity and high productivity, which in turn support important fishing resources and therefore an important fishing activity. Fishing is an essential economic sector for the three countries of the Alboran Sea, generating Jobs and income for coastal communities. The following sections present the main characteristics of the fishery and the impacts of this activity on the marine environment (Fig.10).

General aspects of artisanal fisheries
Artisanal fishing is a heterogeneous group, from the point of view of harvested species near the coast that the multiplicity of techniques, with more than 200 different types of gear. However, there is a great similarity between the three countries, with differences in the type of boat used, areas and fishing seasons. The main technics used are gillnets and longlines, followed by beach seines, trammel nets, traps and hand lines.

General aspects of fishing for demersal species bottom trawl
Catches include a wide variety of species, but only a few are considered target species, both because of the landed volume of their high economic value. The main target are fish species: horse mackerel (*Trachurus trachurus*), hake (*Merluccius merluccius*), blue whiting (*Micromesistius poutassou*), various bream and red mullet (*Pagellus spp, Diplodus spp, Dentex spp...*) (*Mullus spp*.). Among the crustaceans, red shrimp (*Aristeus antennatus*), white shrimp (*Parapenaeus longirostris*) and lobster (*Nephrops norvegicus*). And among the molluscs, the common octopus (*Octopus vulgaris*).

General aspects of the operation seine for small pelagic species
The main species affected by fishing in the Alboran Sea are sardine (*Sardina pilchardus*) and anchovy (*Engraulis encrasicolus*), but other species are also caught, and even if they are of less interest, sometimes they represent a very high percentage of the captured total: horse mackerel (*Trachurus spp*), mackerel (*Scomber spp*), king mackerel or bullet tuna (*Auxis rochei*), billfish (*Scomberesox saurus*) and sardinella (*Sardinella aurita*).

Catches of the two main species, anchovy and sardines, have historically been highly variable due in large fluctuations in abundance, annual recruitment and fishing effort (Fig. 14). Currently, the sardine is fished throughout the Mediterranean coast of Morocco, but with higher production in the following sites: Fnideq, Ras Tarf, Bay of Al Hoceima, Cape Afrou, M'diq, Kaa Srass, Jehba, Ras Al Abid, between Saidia and Al Hoceima and Cape Tres Forcas.

The main breeding and spawning grounds are located, on the Andalusian coast, between Almeria and Malaga; concerning Morocco, on the east coast of Nador around the lagoon of Nador (Ras Kebdana) and the Bay of Al Hoceima; for Algeria, they are not yet well

identified.Malaga Bay is very important for the nursery phase many species of commercial interest, particularly anchovy who realizes its life cycle (eggs, larvae, juveniles and adults) throughout the year. It is also the only site on the Mediterranean coast of Andalusia where this species is fished all year. On the southern shore, the studies conducted to date show a significant concentration of this species between Al Hoceima and Saidia, from Eastern Cape Kabdana up Chafarines islands.

Horse mackerel or European mackerel is present along the Moroccan Mediterranean coast, the largest concentrations in the vicinity of Cape Afrou, the Chafarinas Islands and east of Ras Kabdana, while in Andalusia, his presence is identified at least in the bays of Malaga and Almeria.

General aspects of the exploitation of tuna and related species
The main tuna species exploited in the Alboran Sea are bluefin tuna (*Thunnus thynnus*), albacore tuna and small tuna species such as bullet tuna (*Auxis spp*.), Atlantic bonito (*Sarda sarda*), little tunny (*Thunnus alleteratus*) and, occasionally, skipjack tuna (*Katsuwonus pelamis*). Among neighboring species we can highlight swordfish (*Xiphias claudius*).The fishing area is in the center of the Strait by funds from 500 to 800 m depth.

There is a substantial longline fleet based in Andalusia, fishing mostly in the western Mediterranean. In spring and summer, the target species are swordfish (*Xiphias gladius*), bluefin tuna (*Thunnus thynnus*) and albacore tuna. White tuna surface longline fishing in the area surrounding the Alboran Island and catches represent on average 25% of the total catch in the Mediterranean.

Non-target species caught by the fleet include selacians, particularly blue shark (*Prionace glauca*), shortfin mako (*Isurus oxyrinchus*) and thresher shark (*Alopias vulpinus*), among others.

During the months ofMay and June, a number ofSpanish longlinersfishing for swordfishchange theirequipment tofish bluefin tunato the Japanesetypelonglineat theseamountofSecof Olives(Bank ofChella).

The risks and threats related to fishing activities
The impacts of fishing activities on ecosystems are of different types. Besides the physical alteration of habitats, fishing activities cause a reduction in the size of populations for both species targeted by fisheries for non-target species, alter their demographic structure, and significantly alter the structure and composition communities.

The Alboran Sea is a transition region and concentration of certain marine species (including turtles, cetaceans and large pelagic species) on which the various fishing methods have a negative impact. In general, species are captured in an untargeted way, with or without commercial value. Fishing for species whose conservation status is vulnerable or critical (IUCN Red List or national lists), such as grouper (*Epinephelus marginatus*), red coral (*Corallium rubrum*), many Elasmobranch or shellfish like pen shell (*Pinna nobilis*), or other species, preventing the recovery of these populations.

The Alboran Sea extends from the Strait of Gibraltar to an adopted line running from Cabo de Gata (Almeria, Spain) to the Cape of Oran (Algeria). The region includes 26 important harbours (Spain= 15; Morocco= 8; Algeria= 3). There are two important features that characterize the open sea fisheries from Alboran Sea. On the one hand, there is a marked socioeconomic gradient between Spain (within the European Union) and Morocco and Algeria (two least-developed countries). On the other hand, the Alboran Sea is an important area globally for marine traffic as it provides an important corridor that connects the Mediterranean Sea with the Atlantic Ocean which is crossed by 25% of global maritime traffic. Therefore, the bigger boats of greater gross tonnage could break the fishing gear or collide with slower fishing boats during

fishing operations. Thus, the fishing grounds from open sea in the Alboran Sea are away from the main shipping lanes, and are closer to the coast than in other areas.

The Atlantic Ocean waters entering the Alboran Sea through the Strait of Gibraltar are richer in nutrients than the surface Mediterranean water. For this reason, the plankton productivity levels are highest around the Bay of Malaga, coinciding with the flow of the Western Alboran Gyre (WAG). The plankton productivity peaks occur during spring, summer and autumn, and coinciding with spawning season of European anchovy (*Engraulis encrasicolus*), and sardine (*Sardina pilchardus*). Thus, in the north of the Alboran Sea there are important areas for the spawning of many of fish species near to the coast. Other important reproductive zones are the submarine canyons of the Alboran Sea for demersal fish. The origin of the submarine canyons is related with ancient fluvial erosion processes.

The most important targetted non-tuna species, in weight from open sea are: blue whiting (*Micromesistius poutassou*), horse mackerel (*Trachurus trachurus*), chub mackerel (*Scomber japonicus*), silver scabbardfish (*Lepidopus caudatus*), and Atlantic pomfret (*Brama brama*). Regarding tunas fisheries in open sea from South Alboran Sea the mainly target species are: bluefin tuna (*Thunnus thynnus*), little tunny (*Euthynnus alletteratus*), skipjack tuna (*Katsuwonus pelamis*), plain bonito (*Orcynopsis unicolor*), Atlantic bonito (*Sarda sarda*), bullet tuna (*Auxis rochei*), and swordfish (*Xiphias gladius*). On the other hand, the most important target-tuna and associated fish, in weight for open sea from North Alboran Sea are: bullet tuna (*Auxis rochei*), Atlantic bonito (*Sarda sarda*), swordfish (*Xiphias gladius*), and little tunny (*Euthynnus alletteratus*).
A gradual decline in catches over time in the landing for the major species can be observed; but there is an oscillation trend, in the case of horse mackerel, that shows temporal autocorrelation. Thus, we observed two different peaks, and a decline trend. The Spectral Analysis results indicate that a periodical cycle exists (twelve years periodicity). On the other hand, in the case of chub mackerel we observed temporal autocorrelation.

The sardine abundance trend is positively correlated with the winter North Atlantic Oscillation index (from October to December of previous year) ($r= 0.375$; $p= 0.049$). The North Atlantic Oscillation (NAO) is a dominant pattern of coupled ocean-climate variability in the North Atlantic and Mediterranean basin. We observed a gradual increasing in catches over time; for the landing of little tunny, since 1985 to 2012. Moreover, we found a negative correlation between the landing of bullet tuna from North Alboran Sea and Arctic Oscillation (AO) ($r= -0.38$; $p= 0.046$).

The fishing gears, operating within open sea from Alboran Sea, in the last ten years are: Driftnets (redes a la deriva, filet maillant dérivant), Longliners (palangeros, palangriers): surface longline and bottom longline, Purse Seiners (cerqueros, sardiniers), and Trawlers (arrastreros de fondo, chalutiers).

The endangered loggerhead turtle (*Caretta caretta*) is the most common sea turtle species in the Mediterranean Sea, where it utilizes nesting beaches which are mainly in Eastern basin. Annually, hundreds of juvenile loggerhead turtles, born on the beaches of both the North Atlantic and eastern Mediterranean, are concentrated around the feeding grounds in the western Mediterranean, mainly in waters around the Balearic Islands. In this context, many loggerhead turtles examples are stranded along the southern Iberian Peninsula coast on their way to their feeding grounds or while returning to their natal regions. Due to the spatial overlap in fishing activity and loggerhead turtle distribution, there are tens of thousands of loggerhead turtle by-catches each year. The incidental capture of sea turtle is more frequent in the summer. Based on the testimony of the fishermen interviewed, it appears that surface long-lines interact most frequently with marine turtles, followed by coastal trawlers, purse seiners, and trammel nets. Sea turtles captured by the purse seiners can be released without damage because they do not get tangled up in the net. The incidental capture of sea turtles is rare on trawlers.

The bycatch (or incidental capture) per Unit Effort values in open sea from Alboran Sea are low in comparison to other Mediterranean areas (for example Balearic Sea). However, the by-catch rate of loggerhead turtle by driftnets in the Alboran Sea (0.21–0.78 N/haul) was much higher than that reported for the Italian driftnet fleet (0.04–0.05 N/haul), probably due to a much higher turtle density in Alboran waters linked to the strategic role of this sea in the Atlantic/Mediterranean exchanges.

The landing of sharks, in surface longline, was 34.3% in weight of total catches sampled in the Alboran Sea, which represented the highest shark incidental catches for the Mediterranean Sea. This high shark incidental catches from Alboran Sea, could be probably related to their location (Alboran Sea), i.e. an important migratory channel, adjacent to the Atlantic Ocean. The higher incidence of sharks in the Alboran Sea could also be due to the higher trophic potential of the western Mediterranean compared to the eastern part. Higher shark catches were observed in the swordfish longline fishery, where a nominal CPUE value reached 3.8 sharks/1000 hooks in the Alboran Sea.

From the Alboran Sea, the most important sharks caught in number were blue shark (*Prionace glauca*) and shortfin mako (*Isurus oxyrinchus*). Regarding to the pelagic Batoidea, the unique species reported is the common pelagic stingray (*Pteroplatytrygon violacea*), a bycatches of surface longline. The common pelagic sting ray is the major fish capture in the surface longline from Alboran Sea. Thus, the BPUE of common pelagic stingray is 28.1 stringay per 1000 hooks versus the CPUE of target species 8.42 swordfish per 1000 hooks. We observed a gradual increasing in catches over time; for the landing of tope shark, since 1985 to 2012. Moreover, we found a negative correlation between the landing of tope shark from North Alboran Sea and North Arctic Oscillation ($r= -0.385$; $p= 0.043$). We found a positive correlation between the landing of blue shark from North Alboran Sea and winter Arctic Oscillation Index (between October and November previous year) ($r= 0.57$; $p= 0.043$).

The main gears bycatches demersal elasmobranchs from Alboran Sea are the trawlers and bottom longline. From Alboran Sea the most important demersal elasmobranch caught in number were: gulper shark (*Centrophorus granulosus*), small-spotted catshark (*Scyliorhinus canicula*), and *Raja* spp., that are bycatches of trawlers targeted rose shrimp (*Parapenaeus longirostris*) and great red shrimp (*Aristaeopsis edwardsiana*).

The major problem with of the present data available is to difference between costal fisheries (i.e. small-scale fisheries) and open sea fisheries. On the other hand, the data available from Algeria and Morocco are global (i.e. it are not disaggregated per species) and scarce. Thus it is very difficult analyzed the temporal trend and fisheries profit. In this context, we did not found any paper about bycatch of the fleet from Algeria, or trawlers and longliners vessels from Morocco. For the whole open sea from Alboran Sea is necessary improving the data about CPUE, fisheries profit and bycatch per species.

4.2. Aquaculture

The aquaculture sector has expanded significantly in recent years, especially on the north shore of the Alboran Sea, reaching 8,000 tons in 2007. This was accompanied by an increase in the number of businesses and therefore an occupation whenever largest maritime-terrestrial public domain. The occupancy level at the end of 2006 reached the 7.5 km² to 1.2 km² land and at sea for a total of 70 companies and 120 plants. The exponential growth of this activity and the need to establish criteria for the installation of fish farms has caused the government of Andalusia to conduct studies on the identification of potential sites for aquaculture, on land and at sea in the context of spatial coastal planning.

Another form of aquaculture is practiced in the area, which involves fattening in floating cages near the coast of tuna caught. This activity is directly dependent on fishing for tuna using purse seines or longlines, the only techniques for recovering alive tuna for fattening farms. The recovered tuna are caged for a period of 6 to 7 months, fed with fresh or frozen fish (often recovered by the fleet fishing by purse seine). In Alboran Sea, there is only one such farm near Almeria (Andalusia, Spain), dedicated to the bluefin tuna

On the southern shore, in Morocco, there are only two active aquaculture sites, both in the Bay of M'Diq: a company whose entire production (sea bream and wolves) is for the domestic market (fresh food) and another specializing in the production of molds. In the lagoon of Nador (Sebkha Bou Areg, Nador), there are various applications for authorization for the cultivation of bivalve fattening fish, red algae culture, fattening and marketing of eels caught by fishermen. The exploitation of marine algae is carried out only by a single company that markets the family of algae Gracilaria. A preliminary study of the Directorate of Studies and Financial Forecasts (DEPF 2006) on natural aspects of the Moroccan coast has shown the great potential for aquaculture zones in the following sites: Nador lagoon (March Chica), berries Jebha, Ras Kebdana and Cala Iris (Al Hoceima), the open sea area of M'diq, as well as for offshore mussel farming.

In Algeria, a Master Plan of Aquaculture Development was prepared by the Ministry of Fisheries and Fish Resources, until 2025, by identifying the potential for onshore and offshore mussel farming, oyster farming and mariculture (fattening tuna in floating cages or cultivation of sea bream and wolves). The most promising sites identified are located in the regions (wilayas) of Tlemcen, Ain Témouchent and Oran. Currently, several projects are under development in this part of the Alboran Sea. In the area of Cape Falcon, 20 km to the west of Oran, a nursery bream and wolves should eventually produce 1 million fingerlings which then would be made to grow in floating cages. A Sbiaat, 20 km west of Bouzdjar, another nursery exists for flatfish. A third project is on the island of Rachgoun, 20 kmwest of Beni Saf, with a nursery for the production of sea bream, which would fattening in earthen ponds, with the objective of producing 500 tonnes a year and then grow if possible with floating cages.

The risks of aquaculture activities
Aquaculture practices can affect the biodiversity and natural communities because of pollution, metabolic waste from cultivated species or chemical compounds (antibiotics, antiparasitic, pesticides) used for the production. The accumulation of several organic compounds can cause situations of eutrophic waters or anoxic sediments in the immediate area and the appearance of disease affecting wild populations nearby.

Other impacts of aquaculture activities are related to the introduction of non-native species that cause a decrease in genetic diversity or hybridization with natural populations, and the alteration of natural ecosystems.

On the other hand, capture and fattening bluefin tuna, a species whose conservation status is tricky (endangered according to the IUCN Red List), more fed small pelagics including stock status is not completely known, could threaten the activity of certain categories of fishers who survive on the same resources.

4.3. Maritime traffic

In the Mediterranean, especially on an east-west route, there has been an important maritime traffic into and out of the Mediterranean through the Strait of Gibraltar.

The situation in the Alboran sea

Maritime traffic is one of the most important human activities in terms of impact on the environment and threats to the Alboran Sea. The area of the Alboran Sea is one of the Mediterranean regions (after the Greek islands) recording the largest maritime traffic, because in addition to the specific traffic in the east-west axis, there is a convergence zone for the important traffic axis from the Spanish coast to France or Italy (Fig.23 and 24). According to data collected within the Action Plan activities for the Mediterranean (UNEP-MAP), over 25% of world traffic of merchant ships (60 000 per year and 90,000 by taking into account the Northern Transportation -South and fisheries) would use each year the Alboran Sea.

Because of the intense maritime traffic, the Alboran Sea presents a major risk of accidental pollution in case of collision between ships or spillage related to transportation of hydrocarbons.

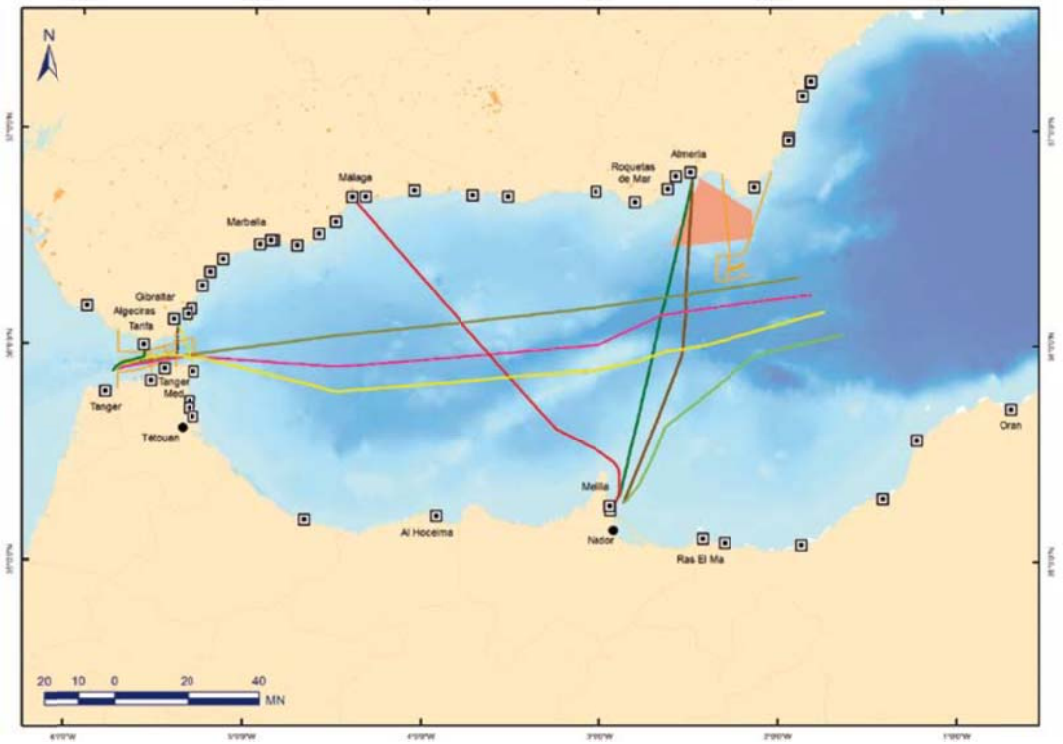


Figure: Main routes of maritime traffic

Considering the trends of 2006, a projection on 20 main routes for transport and Mediterranean travel, including all types of vessels, was conducted for the year 2016. According to these projections, roads sea from Nador to Almeria occupy sixth place in terms of importance depending on the number of crossings / trips, while Gibraltar-Arzew road will occupy the seventh position and Arzew-Gibraltar route thirteenth place in terms of capacity (TPM or DWT) deployed (REMPEC, 2008).

Concerning port development in the western Mediterranean, two new terminals were built to the east of the port of Tangier in Morocco. The project, better known as the Tanger-Med is essentially a transhipment port that aims to treat 3.5 million TEU in 2015 to accommodate larger ships. In fact, apart from the new Tanger-Med port, the majority of ports in this area are overloaded (Algeciras) andthe means to fight against accidental pollution are insufficient in the event of a major accident. In the North, a proposal to expand the port of Tarifa to increase its transport capacity and reception of large vessels was evaluated. This proposal is currently suspended because of the potential damage it could cause to the environment of this area.

The main risk areas of the Alboran Sea

We can identify three main areas at risk:
- The Strait of Gibraltar, crossing all vessels whose routes connect the ports on the Atlantic and northern Europe than in the Mediterranean and ships through the Suez canal (Fig. 26) . The risks of coastal oil pollution are very important and permanent at the strait.
- The Cape Gata area in Spain (Almeria North) or meet the sea routes used by ships between the eastern Mediterranean and the Strait of Gibraltar, with an estimated number of 35,000 crossings a year. In these movements, it should be added approximately 3,000 crossings corresponding to passing ships and cargo ships that provide traffic between Almeria and North African ports.
- The area of the oil port of Arzew in Algeria, in 2006, received 355 ships with a total loading of 40.24 million tonnes of crude oil and 354 ships carrying 15 million tons of liquefied natural gas took place in Arzew. For this period, the loading of ships for distributing oil on the road between Arzew and the South of Spain amounted to 433,076 million tonnes.

4.4. Coastal Development

Economic growth and development have large differences between the northern and southern shores of the region, with eight times growth in the north, visible in areas of industrialization, energy consumption, urbanization, tourism development or population. The planning delays and infrastructure development on the south shore (Morocco and Algeria) and the limited cooperation between the three countries bordering the Alboran Sea, underscore the need for closer coordination in the long term for conservation and sustainable development of the whole basin (Fig. 26, 30-32).

Tourism
On the north shore of the Alboran Sea, the little or unplanned tourism development has a significant direct impact on coastal and marine habitats and watersheds, with many coastal areas erosion phase.On the southern shore, Morocco, the development of tourism in the northern provinces is relatively small, but growing and strong demand along the coast.In Algeria, two-thirds of the country's population is concentrated in the coastal zone. This density grows exponentially during the summer. Because of this high demand, coastal urbanization and the creation of tourist accommodation centres showed dramatic growth with many impacts on the natural environment.

Industry
The north coast has experienced a process of dramatic and sudden transformation in recent decades. Industrial activities in Algeciras Bay and mainly pharmaceutical, metallurgical and petroleum refining, in order of importance, as well as the release of the Marbella desalination plant or Motril various industries are the main sources of polluting compounds.

For the south bank, the main "hot spots", pollution sources at the Mediterranean coast ofMorocco are the cities of Tangier, Tetouan, Nador and, to a lesser extent, Al Hoceima. The Mediterranean coast of Morocco, unlike its Atlantic coast, was less oriented to industrial activities in the past but the growing support of the central governmentregions has changed this, in particular with the creation of Tanger-Med harbour. In Algeria, on the contrary, industrial activities are concentrated in a single point. The industrial pole Arzew involves 12 km of coastline, with specialized ports and an industrial platform with liquid refinery gases and various petrochemical complexes.

Agriculture
Agricultural practices can play a role and present a significant risk to the marine and coastal biodiversity due to inappropriate use of fertilizers and pesticides, transported by rivers or discharged directly into coastal waters, affecting marine habitats. There are few precise

estimates on the amount of fertilizer and other chemicals Alboran Sea transmitted by flowing ponds and rivers.

On the north shore, the development of greenhouses in the region of Almeria, with the large volume of plant and plastic waste they generate, use and abuse of biocides (pesticides, herbicides, insecticides, fungicides, etc.) as well as the depletion and pollution of underground water reserves and generate considerable incalculable environmental impact to the marine environment and the coastline in large part not assessed.

On the southern shore, cropland along the river Moulouya pose a threat to marine and coastal biodiversity and its mouth is an area likely to have repercussions on the South Shore.

The energy and mines

For energy, the Alboran Sea is a point of exchange between the European continent and the African continent, by submarine cables, including cables underwater. Available as regards alternative energy, including wind turbines, in Spain there is an implementation plan offshore wind, prepared in 2007, which did an analysis of the potential based on current techniques.

There is little information about the development of techniques for energy from marine hydraulics, but given the potential of the Strait of Gibraltar, it will bloom proposals.

Regarding the mining sector, at present, it is mainly the extraction of sea sand which poses the greatest problems because it is the easiest option to recharge many beaches in erosion in urban and tourist infrastructure that are the main cause of this erosion, reducing the terrigenous sediment supply. A levy in the sea in front of some beaches will only accelerate the process. For oil and gas, many prospecting campaigns were conducted in the Alboran Sea since 2007 and, despite some fruitful results, new campaigns are planned, mainly to the coast of Andalusia, which are growth sectors tourism and fishing.

For all its activities, and given the importance of the Alboran Sea for biodiversity, it is important that any development project is at least subject to an environmental impact assessment (EIA) and when his scale justifies a strategic environmental assessment (SEA) to define its regional long-term acceptability and in this case the operative conditions to eliminate all risks or implement all response measures in case of accident.

As a summary, to date, the elements that significantly influence the vulnerability of the Alboran area are as follow:

- Excessive urbanization (69% for the Malaga coastline, 62% on the south shore);
- Increase of human activities (fisheries and maritime traffic for the marine environment)
- Land and sea pollution from various agents, particularly the waste of any kind;
- Fragility and scarcity of water resources in the region;
- Desertification (water shortages and salinization of aquifers, erosion by wind and water, deforestation, drought, degradation of pasture areas and culture), decline of agriculture and increase of forest fires (caused and accidental);
- Increase of potentially invasive exotic species;
- Impact on the marine environment by infrastructures and human activities;
- Destruction of coastal wetlands and lagoon systems;
- Volcanic and seismic activity;
- Human impact of the landscape.

5. Definition of a representative network of marine protected areas in the Alboran Sea

Based on specific criteria (see next table), the experts have identified, in each sector considered, the areas where the biological processes and the presence of species of importance for conservation were present and all these elements are summarised in the followinglist of sites and the map presenting the existing and the proposed conservation areas for the Alboran Sea.

Table on the general criteria considered for the creation of a network of MPAs in the Alboran Sea.

Criteria	Details
Geological and geomorphological	Taking into account the great geo-diversity of the region, and in particular: the seamounts, back, canyons and the different geological formations (limestone, volcanic and metamorphic) or sedimentary.
Oceanographic and hydrological	Consideration in particular currents, circulation cells, fronts and deep-water outcrops, transition zones (ecotones) or high productivity.
Representativeness of ecosystem	All ecosystems present in Alboran Sea should be represented in the network and their variability based on hydrological and geomorphological characteristics
Singularity	All singular elements of the region should be part of the network.
Duplication and Replication	Representative elements should, where possible, appear at least twice in the network, preferably on the north shore and the south shore.
Connectivity	When necessary, depending on the cycle of species and their different biological phases, consider the necessary premises to ensure their survival.
Marine fauna	Benthic and pelagic marine fauna species particularly representative of the Alboran Sea, endangered species, migratory species.
Marine flora	In particular marine flora threatened or representative of Alboran Sea species (Posidonia seagrass beds, kelp forests, etc.)
Social acceptance	The protection and management of potential areas should be a consultation process involving their users and their partners (e.g. the fisheries sector)
Economical acceptance	The economic protection must not go against, but to be consistent with the activities essential to the development of states or regions.
Applicability of declaration as protected area	Will clearly expressed legislative and administrative authorities to protect and maintain a website.
Durability	Ability to ongoing funding and adequate management capacity.
Impacts and Risks	Pressures and potential impacts of human activities (especially fisheries, mariculture, marine traffic, cables and pipelines, sources of pollution, tourism ...) are not immediate or direct threats to the sites, or can be mitigated by measures consistent with the principle of sustainable development (e.g. ensuring water quality).

Selection of priority sites for conservation

The following sites have been identified by experts, separated by sub regions.

I. Strait of Gibraltar
I.1. Priorityarea of the Mediterranean Intercontinental Biosphere Reserve
I.2. Priorityarea of Jbel Moussa and Bel Younech (Morocco)
I.3. Priorityarea of the Cirque of Jebha
I.4. Priorityarea of the Gibraltar Strait

II. North-western part of the Alboran Sea
II.5. Priorityarea of the littoral zone between Calahonda and Calaburras
II.6. Priorityarea of the underwater bank of Placer de las Bovedas

III. Djibouti seamounts
III.7. Priorityarea of the Djibouti Seamounts

IV. Almeria
IV.8. Priorityarea of the Gata-Nijar area (Almeria)
IV.9. Priorityarea of the Entinas-Sabinar Cape (Almeria)
IV.10. Priorityarea of the Posidonia barrier reef of Roquetas-de-Mar
IV.11. Priorityarea of the Sec des Oliviers (or Chella Bank)
IV.12. Priorityarea of the Almeria submarine canyons

V. Alboran Island
V.13. Priorityarea of the Alboran island nature reserve
V.14. Priorityarea of underwater platform around the island of Alboran

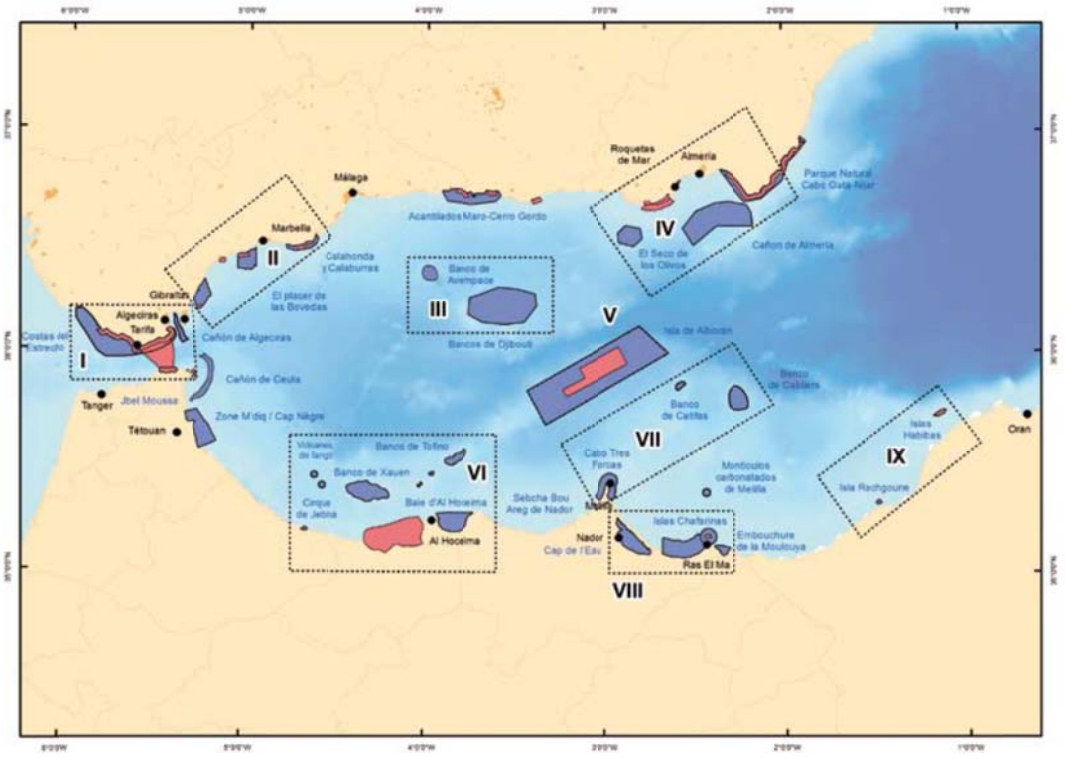
VI. Area of the banks of Xauen and Tofiño, of the coastal zone of Al Hoceima and of the mud volcanoes of Morocco
VI.15. Priority area of the National Park of Al Hoceima
VI.16. Priority area of the Al Hoceima bay
VI.17. Priority area of the banks of Xauen and Tofino
VI.18. Priority area of the mud volcanoes of Morocco Maroc

VII. Area of Trois Fourches: cape and ridge of Trois Fourches
VII.19. Priority area of the Cape of Trois Fourches
VII.20. Priority area of the bakcs of Cablier and Catifas

VIII. North-western coastal area of Morocco
VIII.21. Priority area of the Chafarines Islands (Ya`fariyya)
VIII.22. Priority area of the Ras el Ma (Cap de l'eau).
VIII.23 Priority area of the Lagoon of Nador (Sebkha Bou Areg or Mar Chica)
VIII.24. Priority area of the mouth of the Moulouya river

IX. Area of the escarpment of Yousouf /Habibas, of Habibas islands and Rachgoun island
IX.25. Priority area of the Marine protected Area of Habibas Islands
IX.26. Priority area of Rachgoun island

X. Other sites of interest
X.27. Priority area of the Maro-Cerro Gordo cliffs
X.28. Priority area of the Cape Négro (Kudiet Taifour)
X.29. Priority area of the canyons of Ceuta and Algesiras
X.30. Priority area of carbonated hills of Melilla



Légende

- Région proposée
- Aire marine protégée (AMP) et Site d'Intérêt Communautaire (SIC)
- Nouvelle aire prioritaire pour la conservation marine

Régions

I. Région détroit de Gibraltar
II. Région Alboran nord-occidentale
III. Région monts sous-marins de Djibouti
IV. Région d'Alméria
V. Région Île d'Alboran
VI. Région zone côtière d'Al Hoceima, bancs de Xauen et Tofiño, et volcans de boue du Maroc
VII. Région cap des Trois Fourches
VIII. Région Nord-Est du Maroc
IX. Région Youssouf/Habibas et Rachgoun

References

All the references indicated in this text are listed in the different sectoral reports or in the documents of 2010 and 2012 prepared by IUCN. In addition a full list of publications on the Alboran Sea is available on the IUCN-Med website.