

Chapter 25

Marine Protected Areas and Key Biodiversity Areas of the Alboran Sea and adjacent areas

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Abstract

Marine Protected Areas (MPAs) and Key Biodiversity Areas (KBAs) are important tools for preserving species, habitats and ecological-geological-oceanographical processes. Nowadays, more than 10% of the Alboran Sea is under some protected figure or is on its way to be protected. This chapter presents the current state of the MPAs and KBAs of the Alboran Sea. Most of the habitats included in the Annex I of the Habitats Directive or the Barcelona Convention are represented in MPAs-KBAs of the Alboran Sea. More than 290 threatened species are also occurring in these MPAs-KBAs, but some of them have experienced a strong decline even within them (e.g. *Zostera marina*, *Pinna nobilis*, etc.). Although important progress in the protection of the Alboran Sea has been made in the last decades, there is still much to be done for effective conservation of the habitats and species. The main efforts may focus on improving (1) knowledge of the habitats and species, (2) the surveillance and mitigation against current impacts, (3) the coordination between local, national and international agencies

and (4) the measures for improving habitats and threatened species populations, among others. A deep change in the socio-economic model is then needed for preserving the Alboran Sea natural heritage, promoting then a sustainable use of its resources.

Keywords: Biodiversity, conservation, birds, marine mammals, invertebrates, benthic communities, habitats, impacts.

1. Introduction and historical background of marine and coastal conservation in the Alboran Sea

Biodiversity conservation probably represents one of the biggest challenges for humans in the 21st century, especially considering the continuing human impacts on most of the ecosystems at different scales (Rands et al. 2010). Effective conservation of biodiversity is essential for human survival and as well as for maintenance of ecosystem processes and services. Despite some conservation successes (especially at local scales) and increases of the public and government interest in living sustainably, habitats and species are still declining at an unprecedented rate (Ichii et al. 2019). Moreover, this rate is expected to rise in the future due to human population growth, depletion and inefficient management of natural resources and unsustainable practices affecting on ecosystems, among other causes (Ichii et al. 2019). Marine species and habitats are experiencing a similar decline than terrestrial ones; however knowledge for the marine environment is more limited and marine conservation has always lagged behind terrestrial conservation in most coastal countries (Maxwell et al. 2015). At the end of the 20th century, the concept of protecting certain marine areas was widely accepted and since then this idea has been consolidated with hundreds of Marine Protected Areas (MPAs) established around the world. As their numbers have grown rapidly, so has

their diversity and complexity, MPAs vary dramatically in concept, size, design, purpose, focus, name, and effectiveness (Norse 1993). This same process recognized in other seas and countries has followed a similar trend in the Alboran Sea. In this way, MPAs have been defined by IUCN as “any area of intertidal or subtidal terrain, together with its overlying water and associated flora, fauna, historical and cultural features, which has been reserved by law or other effective means to protect part or all of the enclosed environment” (Kelleher et al. 1999). MPAs represent a traditional way for preserving species, habitats and ecological-geological-oceanographical processes and currently are an important central axis of marine conservation efforts (Kelleher et al. 1999; Kuempel et al. 2019). The benefits of establishing well-designed and enforced fully protected MPAs are well-documented (Giakoumi et al. 2018). Scientific evidence indicates that MPAs can produce ecological, economic and social benefits under appropriate design and management conditions (Ban et al. 2012; 2017).

According to the IUCN (2016), Key Biodiversity Areas (KBAs) are sites that contribute significantly to the global persistence of biodiversity. The identification of a site as a KBA simply implies that the site should be managed in ways that ensure the persistence of the biodiversity elements for which it was considered important. Nevertheless, some KBAs may sometimes not have in itself any character of protection. In this sense, several KBAs can also overlap wholly or partly with existing MPAs, including sites designated under international, national and local levels. Thereby, it is expected that some MPAs overlap with KBAs, however this is not always the case, because MPAs are sometimes established locally by different criteria, and opportunities. IUCN (2016) established global standard criteria for the identification of KBAs worldwide. The main criteria are based on the presence of threatened species/habitats for which site-scale conservation is appropriate, including the importance of such site in the biology,

ecology and preservation of these species and habitats (Butchart et al. 2012, IUCN 2016). Other criteria are that the KBA can host a significant number of endemic/rare species, and/or has a high pristine status. Therefore, MPAs and KBAs designation are useful steps for conservation of global biodiversity, for identification of key sites for elements of biodiversity and for provision of resources to decision-makers that are essential for guiding decisions on the conservation and sustainable management of a particular region.

1.1. International agreements for marine and coastal conservation of the Alboran Sea

MPAs and KBAs have been identified as potentially multifunctional areas which could provide ecosystem and socio-economic services useful for conservation management in the Alboran Sea (Robles 2010; UICN 2012a). These MPAs and KBAs (without IMMAS) cover ca. 7% of the world's ocean (UNEP-WCMC IUCN 2017), whereas in the Alboran Sea these areas represent ca. 10%. The political scenario of the Alboran Sea region is characterized by a clear division between the north and south sectors, and national interests predominate both north and south in terms of the maritime map, with a resulting mosaic of jurisdictions that facilitates neither bilateral nor multilateral agreements (Talamo and Riera 2019). The north-south asymmetry of the Alboran Sea can also be seen in the existence of two distinct and greatly differing socio-economic and cultural models. The north has high or very high human development indicators, whereas the south has average human development indicators.

International agreements have been helpful in the designation of some of the MPAs and KBAs of the Alboran Sea. Some of the most widely known KBAs focussing on vertebrates are the Important Bird and Biodiversity Areas (IBAs) adopted by Birdlife International and the Birds Directive (2009/147/EC) (only in countries of the European

Union) and Important Marine Mammal Areas (IMMAs) adopted by IUCN (IUCN 2016). The Biosphere Reserves (e.g. Cabo de Gata-Níjar, Intercontinental of the Mediterranean) recognized by the UNESCO Man and Biosphere Program are areas made up of terrestrial, marine and coastal ecosystems. The objectives of this UNESCO program are to promote solutions to reconcile the conservation of biodiversity with its sustainable use, economic development, research and education. Global Geoparks, also recognized by the UNESCO (e.g. Cabo de Gata-Níjar) are single, unified geographical areas where sites and landscapes of international geological significance are managed with a holistic concept of protection, education and sustainable development. Their bottom-up approach of combining conservation with sustainable development while involving local communities is becoming increasingly popular. The Ramsar Convention aims to the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world. In the Alboran Sea, this convention has recognized three Ramsar Sites in Spain (Cabo de Gata-Níjar, Punta Entinas-Sabinar, Albufera de Adra) and another three in Morocco (Cape Trois Fourches, Sebkhah Bou Areg, Mouth of River Moulouya). Another figure is the Specially Protected Areas of Mediterranean Importance (SPAMI) that are areas declared under the Protocol on Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD Protocol) under the Convention for the protection of the marine environment and from the Mediterranean coastal region (also known as Barcelona Convention 1995). These SPAMIs guarantee the survival of the biological values and resources of the Mediterranean Sea, since they contain typical ecosystems of the Mediterranean area or habitats of endangered species, which have a special scientific, aesthetic or cultural interest. It is also important to highlight the Ecologically or Biologically Significant Marine Areas (EBSAs)

recognized by the Convention on Biological Biodiversity (CBD). In 2009, the ninth meeting of the CBD-COP9 adopted different scientific criteria for identifying ecologically or biologically significant marine areas in need of protection in open-ocean waters and deep-sea habitats (Malcolm et al. 2014). The Regional Workshop of the Mediterranean region agreed on the description of 17 areas meeting EBSA criteria, among them the Strait of Gibraltar, Alboran Sea and connected Spanish, Moroccan and Algerian areas. In 2014, despite the positive results of this workshop, the COP 12 of CBD governments have not reached an agreement in the same direction, therefore, to date, it appears not feasible the creation of an EBSA area in the Alboran Sea. Talamo and Riera (2019) aimed to renew and underline the importance and value added of creating an EBSA to support more and better cooperation in the policies of conservation and sustainable development of the Mediterranean Sea. A recent concept is the Peace Park which is defined as 'transboundary protected areas that are formally dedicated to the protection and maintenance of biological diversity and of natural and associated cultural resources, and to the promotion of peace and cooperation' (Sandwith et al. 2001). In 2010, during the CIESM workshop in Siracusa (Italy), eight Peace Parks were proposed for the Mediterranean Sea, being the Near Atlantic Marine Peace Park (Ibero-Moroccan Gulf, Straits of Gibraltar and the Alboran Sea) the first one of them (Aguilar et al. 2010). An integrated governance framework as set out in process may offer appropriate horizontal tools to help policy makers and economic and environmental actors to join up their policies, interlink their activities and optimize the use of marine and coastal space in an environmentally sustainable manner.

Another international tool for preservation on marine life has been through the Convention on International Trade in Endangered Species of Wild Fauna and Flora

(CITES). Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival. Roughly 5800 species of animals and 30000 species of plants are protected by CITES against over-exploitation through international trade, and some of them are present in the Alboran Sea (e.g. black corals, red coral). These species are listed in the three CITES Appendices according to how threatened they are regarding international trade.

1.2. Marine and coastal conservation in the Spanish sector of the Alboran Sea

The Spanish legislative framework regulating the figure of MPA, focused on maintaining the sustainability of the marine environment and biological diversity, is referred to the Law on Natural Heritage and Biodiversity (Law 42/2007, of December 13) that identifies the MPA concept for the first time and contemplates the creation of a network of MPAs. This law thus incorporated into the Spanish legal system the possibility of creating MPAs and also established different protection figures: Natural and National Parks (Parques Naturales, Parques Nacionales), Natural Reserves (Reservas Naturales), MPAs, Natural Monuments (Monumentos Naturales) and Protected Landscapes (Paisajes Protegidos) (Fig. 1) (Mateo-Ramírez et al. 2020a), depending on the assets and values to be protected as well as the management objectives to be met. Later on, the Marine Environment Protection Act (March 12, 2010; BOCG 121/000059) addressed new aspects of marine environment protection and management, with three key elements: (1) marine strategies as a planning instrument, (2) the creation of a network of MPAs and (3) the incorporation of environmental criteria in the uses of the marine environment. Previously the Law 1/2002, of April 4, regulated the management, promotion and control of marine fishing, shell fishing and marine aquaculture (BOE106 / 2002 of May 3, 2002, p. 16189; BOJA45 / 2002 of April 04,

2002). Legislation at the autonomous level of Andalusia has also created different regulations for the protection of marine natural areas and their resources. In 1989 (Law 2/1989 of July 18, BOJA 60 of July 27) the inventory of the Protected Natural Areas of Andalusia was approved. Currently, more than 30 years later, the Network of Protected Natural Areas of Andalusia (Red de Espacios Naturales Protegidos de Andalucía, RENPA) is composed of 249 protected areas, with ca. twenty of them marine. This network includes, among others, the following national and regional protection figures (only those with marine spaces are mentioned): Natural Park (Parque Natural), Natural Area (Paraje Natural) and Natural Monument (Monumento Natural) (Fig.1). In the context of the Alboran Sea, it should be noted that the Cabo de Gata-Níjar Natural Park (maritime-terrestrial), declared in 1988, is considered the first MPA *sensu stricto* (in this case mixed), declared in the Spanish state (Ortiz García 2002).

Spain is an EU member and, therefore, has to fulfil with community policies regarding environment. Considering that other protection figures have been developed at European level, under the framework of the Natura 2000 Network, such as Site of Community Importance (SCI) (previous step without management plan) and Special Areas of Conservation (SAC) (once a SCI has approved a management plan) (Council Directive 92/43/EEC of May 1992 - Habitats Directive) and Special Protection Areas for Birds (SPA) (Council Directive 79/409/EEC of April 1979 - Birds Directive - actually Directive 2009/147/EEC). It is interesting to clarify that, currently, some MPAs of the Andalusian coast included in the Natura 2000 Network are managed by the Spanish Government and others by the Andalusian Government (Fig. 1). The Habitat Directive (HD) on the conservation of natural habitats and of wild fauna and flora aims to promote the maintenance of biodiversity, taking account of economic, social, cultural and regional requirements. It forms the cornerstone of Europe's nature conservation

policy, together with the Birds Directive (BD), and establishes the wide EU Natura 2000 ecological network of protected areas, safeguarded against potentially damaging developments. Over 1.000 animal and plant species, as well as 200 habitat types, listed in the HB annexes are protected in various ways. The BD is one of the oldest piece of EU legislation for environmental conservation and one of its cornerstones. Amended in 2009, it became the Directive 2009/147/EC and it places great emphasis on the protection of habitats for endangered and migratory birds. It establishes a network of Special Protection Areas (SPAs) including all the most suitable territories for these species. Since 1994, all SPAs are included in the Natura 2000 ecological network, set up under the HD. The ca. 500 wild bird species naturally occurring in the European Union are protected in various ways under the annexes of the BD.

Another tool for the conservation of wild flora and fauna in Spain is provided by the National Catalogue of Threatened Species (Catálogo Nacional de Especies Amenazadas), regulated by the Royal Decree 439/1990, under the List of Wild Species under Special Protection Regime (Listado de Especies Silvestres en Régimen de Protección Especial, LESRPE). Both the Catalogue and the List have been later on updated in 2011, 2012, 2015, 2016 and 2019. In that list, the species are categorized according to their degree of threat for their persistence and in accordance to some specific measures for the recovery of their populations. Likewise, and following a similar approach, the Andalusian Catalogue of Endangered Species (Catálogo Andaluz de Especies Amenazadas) has been elaborated under the framework of the Andalusian List of Wild Species under Special Protection Regime (Listado Andaluz de Especies Silvestres en Régimen de Protección Especial, LAESPE) (Decree 104/1994, of May 10). Both the List and Catalogue were also updated in 2003 and 2012.

1.3. Marine and coastal conservation in the Moroccan sector of the Alboran Sea

In Morocco, several institutions are involved in the conservation and management of its marine biodiversity, including various coordination, management, monitoring and control institutions. The Moroccan Fourth National Report on Biodiversity (2009) contains the Moroccan strategy for the conservation and sustainable use of its biodiversity. Morocco has made great strides in creating an institutional and legislative framework for the conservation and management of biodiversity. One of the first steps was done with the legal regulation on maritime fishing of November 23, 1973 and its revisions, which aimed to guarantee the sustainable management of fishery resources. In this law, it is important to highlight the laws on Maritime Fisheries Code and on the preservation of marine ecosystems and of the coastline. The Law no. 11/2003 represented another step towards conservation, focussing on the enhancement of the environment in which "Specially Protected Areas" are defined as those "terrestrial or marine spaces with a particular natural and cultural value within which measures must be taken for the protection and environmental management". A new law on protected areas was adopted in July 2010 and it defines the roles and responsibilities of the different administrations and the possibility of delegating the management of these spaces. Regarding the law, the figures of protected spaces are grouped into the categories of National Park (Parc National), Natural Park (Parc Naturel), Biological Reserve (Réserve Biologique), Natural Reserve (Réserve Naturelle) and Natural Site (Site Naturel) (Fig. 1) (Mateo-Ramírez et al. 2020a).

Regarding conservation sites, Morocco has developed an initiative to identify sensitive areas in relation to their ecological functions, such as feeding, breeding and/or breeding sites for the main demersal species, and their richness in biodiversity, including fauna and flora species that sometimes unique at the regional level. These areas, under the

responsibility of the Water and Forest Administration, are declared as Sites of Biological and Ecological Interest (Site d'intérêt Biologique et Écologique, SIBE, Fig. 1) of priority 1, 2 or 3, according to the following definition: Priority 1 SIBE: areas that must be declared under some protection status (such as the Nature Reserve) for a period of 5 years; Priority 2 SIBE: areas that must receive a protection status for 10 years; Priority 3 SIBE: areas where any human activity is excluded and must enjoy a protection status for a period of 10 years.

1.4. Marine and coastal conservation in the Algerian sector of the Alboran Sea

In Algeria, the legislation on marine and coastal areas has adopted during the last decades regional and international legal instruments to which the country is signatory (Boubekri and Djebbar 2016). The development of protected areas through the National Framework of Land Management (Schéma National d'Aménagement du Territoire) constitutes the cornerstone of in situ conservation of biological diversity in Algeria. As part of its environmental strategy, an important effort is being carried out aimed at the knowledge and protection of coastal marine areas of relevance to biodiversity, as well as complementary actions for the development of a management plan in a series of preselected areas (e.g. Habibas islands). According to this strategy, measures related to the protection and conservation of the coastal heritage will be applied in the future. Changes in national legislation to adapt the country to the international legal background include a Law on Land Use (2001), relative to the organization and sustainable development of the territory, together with Coastal Law No. 02-02 (2002), followed by enactment of Coastal Area Management Programs in 2003 and creation of the CNL (National Commission for the Littoral) in 2004 to coordinate the management of Marine Nature Reserves in Algeria. According to Boubekri and Djebbar, (2016) the interest in the establishment of MPAs in Algeria started in the 1980's. At that time,

there was a lack of legislative structures for their designation, and only one location (Banc des Kabyles) was declared a Marine Reserve as part of Taza National Park. Later on 2002, Law No. 02-02 on the protection and valorisation of the coast, encouraged the creation of a second MPA, which was subsequently established at Habibas Islands in 2003 under Decree No. 03.147. The purpose of that law is the elaboration and application of a specific national policy for the management and protection of the coast. The law 11-02 of February 2011 defined the functions and responsibilities of the different administrations and the possibility of delegating the management of protected areas. According to this law, the following categories were established: National Park (Parc National), Natural Park (Parc Naturel), Integral Nature Reserve (Réserve Naturelle Intégrale), Nature Reserve (Réserve Naturelle), among others (Fig. 1) (Mateo-Ramírez et al. 2020a). For this, the law institutes a National Commission of Protected Areas that will be in charge of evaluating the proposal and categorization of each proposed area. The management of each proclaimed area falls also on the institution that prepares the proposal.

2. Important Marine Mammals Areas and other cetacean critical areas within the Alboran Sea

The IUCN expert group for Marine Mammals has identified a set of KBAs known as Important Marine Mammals Areas (IMMAs), which are defined as “discrete portions of habitat, important to marine mammal species, that have the potential to be delineated and managed for conservation” (Corrigan et al. 2014, Hoyt 2015). Currently, the IMMAs have no status and their proposal as protected areas have to make by the coastal countries that have the authority to implement. Some IMMAs described in different basins (IMMA group 2020) overlap, and the Alboran Sea represents an example

regarding this, since the entire basin and its adjacent areas (e.g. Strait of Gibraltar) host four different IMMAs (Figure 2) known as: Alboran Corridor IMMA, Alboran Deep IMMA, Alboran Sea IMMA and Strait of Gibraltar and Gulf of Cádiz IMMA. Thus, within the Alboran Sea, IMMA areas cover a large proportion of the Alboran Sea, overlapping. Table 1 shows the area covered by each IMMA, and the main marine mammals for which each IMMA has been delineated. For more details on the biology of those cetaceans, and of the main threats within the Alboran Sea, please consult Báez et al. (Chapter 21, of this volume).

A recent study based on opportunistic sightings assessed the suitability of IMMAs for cetacean conservation in the Western Mediterranean Sea. In this same study, Báez et al. (2019) demonstrated the higher abundance of cetaceans in IMMAs of the Alboran Sea compared to those in other Mediterranean IMMAs.

3. Important Bird and Biodiversity Areas

The Important Bird and Biodiversity Areas (IBAs) are sites of international importance for bird conservation on land and sea, which have world-wide recognition as practical conservation and management tools (Donald et al. 2018). The concept of IBA has been applied during the last decades and a big effort has been made to agree on a robust and simple criterion to be applied consistently worldwide. The selection of these important areas has been completed through the use of quantitative ornithological data and considering up-to-date knowledge of the sizes and trends of bird populations. In this way, it is ensured that all selected IBAs are of high interest for bird conservation at the international levelling terms of the presence and abundance of species that occur there seasonally or all year round (Heath et al. 2000).

At present 1873 out of 13599 existing worldwide IBAs are exclusively marine IBAs (www.birdlife.org/datazone/site, accessed 3rd April 2020). Spain and Portugal were pioneers in the design of marine IBAs in the open sea, where these important areas for birds typically coincide with areas of interest for other organisms, such as cetaceans or marine turtles (Arcos et al. 2009). The Alboran Sea hosts 9 marine IBAs, which cover an area of 718766 km² and include representatives of “areas of high-intensity use at sea”, “seaward extensions of breeding colonies”, and “migration hotspots”. Furthermore, there are 6 IBAs in the Alboran Sea occupying inshore (coastal) waters (see Table 2).

The Strait of Gibraltar, in the Western limit of the Alboran Sea, is the only connection between the Atlantic Ocean and the Mediterranean Sea and represents a clear example of a bottleneck for seabirds, with migrants being constrained from both sides into a narrow front of only 14.4 km at the nearest point between the European and African coasts. It concentrates the majority of seabird populations entering and leaving the Mediterranean Sea, being especially remarkable the cases of three Mediterranean endemic species, the Balearic and Scopoli's Shearwaters and the Audouin's Gull, as well as the Mediterranean Gull and the Northern Gannet, among many others. Tarifa Island is a strategically located point from where populations of some species can be estimated through coast-based counts (Arroyo et al, 2016). From this point to the East, the Alboran Sea as a whole could consider a migration corridor, with certain areas of special interest where seabirds occur in high numbers for foraging purposes, as the bays of Málaga and Almería, and several locations that host important breeding colonies of species listed in Annex I of EC Birds Directive, as the Audouin's Gull or the Scopoli's Shearwater (see Table 2).

Seabirds are one of the most threatened groups of birds at global level, mostly due to human activities at sea and on land, especially in their colonies (Croxall et al. 2012). As the identification and designation of IBAs do not guarantee full legal protection, conservation initiatives should be implemented to ensure the protection of the most interesting enclaves and areas, including the open sea. The regular monitoring of the IBAs, together with the identification and assessment of the main threats affecting the species all year-round, would be important tools to guide and design effective conservation and management initiatives. This is particularly important because most of the seabirds inhabiting the Alboran Sea are highly mobile species (González-Solís et al. 2007, Bécares et al. 2016, Pérez-Roda et al. 2017).

4. SPAMIs and other overlapping-connected Marine Protected Areas

The Specially Protected Areas of Mediterranean Importance (SPAMIs) are marine and coastal sites for conserving “the components of biological diversity in the Mediterranean, ecosystems specific to the Mediterranean area or the habitats of endangered species, which are of special interest at the scientific, aesthetic, cultural or educational levels”. These SPAMIs were created under the Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (SPA/BD Protocol) and the contracting parties to the Barcelona Convention (BC). The SPA/BD Protocol was adopted in 1995 and called for the creation of SPAMIs, however entered into force in 1999. Nowadays there are 35 SPAMIs in the Mediterranean Sea, with 6 of them located in the Alboran Sea and its adjacent areas (<http://www.rac-spa.org/spami>); New SPAMIs could be included in the future as this is an ongoing process. The SPAMIs have to follow the criteria listed in the Annex I of the SPA/BD Protocol: a) uniqueness, b) natural representativeness, c) diversity, d) naturalness, e) presence of

habitats that are critical to become endangered or threatened or to harbour endemic species and f) cultural representativeness. In addition, they have to follow the procedure and the stages to be included as SPAMI in the List. SPAMIs are one of the most important networks of MPAs recognised by all Mediterranean country signatories to the BC. Each SPAMI needs a management plan and all the parties of the SPA/BD protocol are committed to respect the protection and conservation measures defined in the proposal for inclusion.

The main SPAMIs located in the Alboran Sea are presented from west to east direction and from north to south order. In some cases these SPAMIs also overlap with other figures of protection, which has also been indicated and explained.

4.1. Maro-Cerro Gordo Cliffs SPAMI and collateral figures of protection (Spain)

The Maro-Cerro Gordo cliffs (Acantilados de Maro-Cerro Gordo) are located on the northern part of the Alboran Sea, between Nerja (Málaga) and Almuñécar (Granada). It includes a narrow strip of 12 km along the coast, from Maro beach to Cerro Gordo cliff, which contains a series of small beaches, coves and cliffs (Fig. 3). The total extension of this maritime - terrestrial site is 19.13 km², of which 3.84 km² are terrestrial and 15.29 km² are marine (one nautical mile from the coastline) with a depth range from the coast to ca. 70 m in front of Cerro Gordo cliff. In these cliffs the outcrop of various units of the Alpujárride Complex occurs where the age of the rocks and their degree of metamorphism increases generally towards the east, consisting of Middle-Upper Triassic carbonates or marbles, together with mica-schists and quartzites of low metamorphic grade and Lower-Middle Triassic age, graphite schist of middle to high metamorphic grade and locally migmatitic gneiss both of Palaeozoic age.

This MPA was firstly declared as Natural Area (Paraje Natural) by the Andalusian Government (Junta de Andalucía) in July 1988 and it represents one of the few MPAs within the RENPA that is also a SPAMI. In October 2002, this MPA was classified as Special Protection Area (SPA, ES6170002) according to the Birds Directive (BD), but due to its relevance in the Mediterranean basin, it was also declared as SPAMI in 2003. Later on, the SPAMI was also confirmed as a Site of Community Importance (SCI) (Acantilados de Maro-Cerro Gordo, ES6170002) in July 2006 and designated as a Special Area of Conservation (SAC) in January 2015, in compliance with the Habitats Directive (HD).

The confluence of Atlantic and the Mediterranean waters, the occurrence of upwellings, the presence of soft (with variable grain sizes) and rocky bottoms, cliffs and underwater seawalls and submerged caves makes this a privileged location where several types of marine habitats and a high biodiversity has been described (Rueda and Marina 2009). Around 16 types of natural habitats included in Annex I of the HD are present, four of which are strictly marine: Sandbanks which are slightly covered by sea water all the time (Habitat 1110), Reefs (1170), Submerged or partially submerged sea caves (8330) and the priority habitat *Posidonia* beds (1120) (Mateo-Ramírez et al. 2020b). The most representative structure for the habitat 8330 is the Cerro Gordo cave, which has ca. 100m length and that present a diverse fauna assemblages that changes towards the end of the cave. (<https://litoraldegranada.ugr.es/>).

Moreover, some vertebrates included in Annex II of the HD have also been detected such as the Striped Dolphin (*Stenella coeruleoalba*) (Fig. 3), or the Loggerhead Turtle (*Caretta caretta*) as well as birds species such as Mediterranean Gull (*Ichthyaetus melanocephalus*), the Audouin's Gull (*Ichthyaetus audouinii*), the Sandwich Tern (*Thalasseus sandvicensis*) (Fig. 3) and the Osprey (*Pandion haliaetus*) during migration

and winter, the Cory's and Scopoli's Shearwaters (*Calonectris borealis* and *C. diomedea*, respectively) during migration and summer, and the Peregrine Falcon (*Falco peregrinus*) breeding in coastal cliffs, all included in Annex I of the Birds Directive (2009/147/EC) (Mateo-Ramírez et al. 2020c).

A wide variety of fish species occur in this MPA, such as the Sunfish (*Mola mola*), the Ornate Wrasse (*Thalassoma pavo*), the African Striped Grunt (*Parapristipoma octolineatum*), the Pearly Razor Fish (*Xyrichtys novacula*) or *Opeatogenys gracilis*, a small cryptic fish that inhabits the seagrass meadows (Rueda and Marina 2009). In the rocky reefs it is still possible to spot some Dusky Grouper (*Epinephelus marginatus*) and shoals of the Grey Triggerfish (*Balistes capriscus*), being the only member of the balistidae family in the Mediterranean Sea. The invertebrates in this MPA are also of importance, with some of them included in different conventions, the HD or the Listado de Especies Silvestres en Régimen de Protección Especial (LESRPE) from the Spanish Government, such as the Hatpin Urchin (*Centrostephanus longispinus*), the Star Coral (*Astroides calycularis*), the Knobbed Triton (*Charonia lampas*) as well as the vermetid *Dendropoma lebeche* (previously known as *Dendropoma petraeum*, Templado et al. 2016) classified as "Vulnerable" (Vulnerable) or the endangered Ribbed Mediterranean Limpet *Patella ferruginea* as "En Peligro de Extinción" (In Extinction Risk) in the Catálogo Español de Especies Amenazadas (CEEAA), the scarce and beautiful Brown Cowry (*Luria lurida*), (Endangered species in the BC) and the Noble Pen Shell (or Fan Mussel) (*Pinna nobilis*) (included in the Annex IV of the HD and in Annex II of the SPA/BD Protocol) (Fig. 3). The Noble Pen Shell has practically disappeared since 2016 due to the cryptogenic parasite *Haplosporidium pinnae* that caused an extensive mass mortality of this large and endemic bivalve in the Mediterranean Sea (Catanese 2018; Templado et al. Chapter 10 in this book). In the underwater caves and hard bottoms,

different gorgonians (the Pink Sea Fan *Eunicella verrucosa*, the Violescent Sea-whip *Paramuricea clavata*, *Leptogorgia sarmentosa*), some of them listed as Vulnerable in the Libro Rojo de los Invertebrados de Andalucía occur. Biological communities of some seagrass beds of this MPA (e.g. *Zostera marina*, *Posidonia oceanica*) have been studied and displayed a high diversity of fauna, but unfortunately they have experienced a strong decline in the last years (Rueda et al. Chapter 09 of this volume).

Agriculture and fisheries (mainly, artisanal purse seining, gillnetting, and longlining) have historically sustained human settlements around the MPA, but the increasing tourism and recreational activity offered by its natural environment has nowadays taken on enormous importance. Nevertheless, this represents one of the main impacts on this MPA, especially during summer when tourist affluence increases. Unauthorized activities such as free camping, transit and anchoring of motor boats, recreational fishing or scuba diving, as well as urban solid waste and untreated sewage from nearby villages (e.g. Nerja) are the main threats. In the same way, agriculture greenhouses have proliferated in recent years in the western part of the MPA (e.g. Maro village), generating a high visual impact and a large amount of solid (plastic) and liquid (pesticides, fertilizers, etc.) waste, which can negatively affect the long-term stability of habitats that are sensitive to coastal water quality such as seagrass beds. This together with some illegal bottom trawling was postulated among the potential drivers that led *Zostera marina* beds to their local extinction (Rueda et al. 2009).

4.2. Alboran Island SPAMI and collateral figures of protection (Spain)

The Alboran Island is a small and flat island, 642 m long and 265 m wide, located in the centre of the Alboran Sea from which it received its name. It belongs administratively to the Almería province, distant ca. 85 km and is situated ca. 55 km away from Morocco.

The island is of volcanic origin and represents the top of the Alboran Ridge, an elongated submarine seamount that is one of the main structural highs of the Alboran Basin. This island is flat (not exceeding 15 m in height) with an irregular morphology, as well as the surrounding insular platform, due to the abrasive marine erosion. It corresponds to an outcrop of volcanic breccias and tuff of the calcoalkaline series that varies from pyroxene andesites to basalt-andesites, of Upper Tortonian age (IGME 1983; Aparicio et al. 1991). This outcrop is abraded by several levels of quaternary marine terraces with detrital limestone deposits, which provide a characteristic tabular relief to the island, and covered by a deposit of Holocene eolic sands (IGME 1983).

The island is located on a linear NE-SW elongated platform that is ca. 45 km long and 10 km wide, and is disconnected from the nearest continental areas (Bárcenas et al. 2004). The platform is located in the NE sector of the Alboran Ridge, an elevation of ca. 200 km in length which controls the physiography of the southern part of the Alboran Sea. This structure is made up of a series of tight anticlinal-syncline folds generated since the Upper Tortonian to the present and are located over a main thrust (Vázquez et al. 2015a) according to the convergence of the Nubian plate towards the northwest (Vázquez et al. Chapter 5 of this volume). This elevation is dotted with volcanic outcrops, highlighting the trapezoidal building that corresponds to the basal Alboran island edifice (Vázquez et al. 2004).

The insular platform is connected to a high slope flank that extends down to 1000-2000m (Vázquez et al. 2015a). The morphology and sediments spatial distribution indicates the existence of two different hydrodynamic areas on the Alboran Ridge (Bárcenas et al. 2018): a) The northern area with energetic hydrodynamics and a predominance of erosive processes together with the presence of kelp beds (Fig.4), which have been found in very specific areas of the Mediterranean subjected to Atlantic

influence (Templado et al. 2006) and b) the southern area with less energetic hydrodynamics conditions, mostly harbouring muddy sediments, but with a high biotic productivity associated with upwelling currents, as occurs off the Málaga coast. These could be responsible of the formation of rhodoliths and higher concentration of biogenic gravel and carbonates.

The first two protection figures of the area surrounding the island, a Marine Reserve (4.29 km²) and a Fishing Reserve (ca. 490 km²), were declared in 1997 by the Spanish Ministry of Agriculture, Fisheries and Food (MAPA). The fisheries regulations in the Marine Reserve were revised in 2018, with a ban of bottom trawling between 0 and 100 m and below 1000 m. In 2001, the Alboran Island, with its underwater platform, was declared SPAMI, according to the BC. In 2003, the Andalusian Government declared the island and its platform (ca. 264.56 km²) a Natural Area (Paraje Natural) and the management plan for this and the associated SPAMI was approved in 2005. In 2003, the terrestrial part (ca. 0.8 km²) was also declared a SPA (SPA ES0000336). In 2006, a SCI (SCI ES6110015), coincident with the marine part of the Natural Area (ca. 263 km²) was approved for the Alboran Island platform. In 2014, just after the Life+ INDEMARES project, a new SCI proposal was adopted and named as Espacio Marino de Alboran (Marine Space of Alboran) (ESZZ16005), which expanded the extension of the previous SCI (an additional 108.9 km²). The objectives of the Life+ INDEMARES project were to characterize and identify the main habitats and biocoenoses of this offshore area, to evaluate their conservation status and possible threats, and to propose management measures in order to include this site in the Natura 2000 Network. The Life+ INDEMARES studies covered an area of 2753.46 km², which corresponded to the platform surrounding the island of Alboran down to 200 metres depth. Finally a new SPA (ES0000505) named Espacio Marino de la Isla de Alboran (Marine space of the

Island of Alboran) (ca. 661 km²) was declared in 2014. Albeit the Andalusian Government declared in 2015 a SAC (ES6110015) for the Alboran Island (BOJA 2015/153) with associated Management Measures (BOJA 2015/193), alleging an ecological continuity between the terrestrial and the marine adjacent area, the Superior Court of Justice of Andalusia cancelled both orders in 2017 (Order of December 18th, 2017 in BOJA 244/2017). The main reason for that was that the ecological continuity between the land and the adjacent marine area could not be credited. Therefore, the competence for declaring and managing both SCIs (ES6110015 and ESZZ16005) corresponds nowadays to the Spanish Government. This judgment does not affect the Natural Area and its Management Plan which remains in force under competence of the Andalusian Government.

The terrestrial part of the MPA is the home of interesting endemic plants such as *Diplotaxis siettiana* and *Senecio alboranicus* (Mota et al. 2006), as well as of few invertebrates (Paracuellos et al. 2006). Nowadays, the colony of the Audouin's Gull of the Alboran Island is the main one for the Alboran Sea, and it has suffered an increase of its population up to 800 breeding pairs reported in 2019 (Paracuellos and Nevado 1995, 2003, 2010; SEO CEUTA 2019). Several cetaceans display important populations in the waters around the island (Fig. 4), such as the Cuvier's Beaked Whale (*Ziphius cavirostris*) (Annex IV of the HD among other conservation lists) (Mateo-Ramírez et al. 2020c) and the Risso's Dolphin (*Grampus griseus*) (Annex V of the HD among others) (Mateo-Ramírez et al. 2020c) (Cañadas et al. 2005; Junta de Andalucía, 2011).

The Alboran Sea has been considered a hot spot of marine biodiversity within the Mediterranean Sea (Rueda et al Chapter 9; Templado et al. Chapter 10 of this volume); hosting most of the Andalusian threatened marine species (Barea-Azcón et al. 2008). The marine biodiversity of the Alboran platform is very rich. The macroalgae, with 220

known species, are very abundant in the sublittoral zone, including extraordinary forests of the kelp *Laminaria ochroleuca* that surrounds the Alboran Island between 30 and 60 m depth (Fig. 4). Nevertheless, seagrass meadows which otherwise characterize most of the coastal protected areas of the Alboran Sea are completely absent around the Island (Moreno 2006). Thirteen benthic communities have been identified in the sublittoral bottoms of the Alboran Island and its platform during the INDEMARES+Life project (Gofas et al. 2014). From these, the rhodolith beds (related to Habitat 1110 of the HD), which extend from 20 to 100 m depth should be highlighted (Mateo-Ramírez et al. 2020b). More than 300 species of invertebrates have been identified in this habitat; some of them shared with coralligenous and with coarse bioclastic bottoms. Two different communities are found on circalittoral rocky bottoms (Habitat 1170 of the HD) surrounding the Alboran platform. A shallower occurring one (coralligenous), between 30 and 100 m depth, is very heterogeneous and rich in species. In this habitat the most conspicuous are the gorgonians (Pink Sea Fan, Violescent Sea-whip or *L. sarmentosa*). Some colonies of the Red Coral (*Corallium rubrum*) (Annex V of the HD between other conservation lists) (Mateo-Ramírez et al. 2020c) can be present from 50 to 150 m depth, under overhangs of the rock. Some species of echinoderms, such as the sea urchins *Sphaerechinus granularis*, *Gracilechinus acutus* and the Hatpin Urchin (Annex IV of HD between others) (Mateo-Ramírez et al. 2020c) as well as the ophiuroid *Astrospartus mediterraneus* are frequent, the latter usually attached on the gorgonians. On deeper rocky bottoms, from 100 to 200 m depth, there are different species of gorgonians, such as *Viminella flagellum*, *Acanthogorgia hirsuta*, *Eunicella filiformis* and *Callogorgia verticillata*. The latter is characteristic of the bathyal, but it reaches the edge of the platform in the Alboran Island. Some deep rocky bottoms harbour the so-called “Sponge Gardens” with some interesting species, such as *Phakellia robusta*, *P.*

ventilabrum, and the “lollipop” sponge *Crella pyrula* or the Atlantic *Asconema setubalense* among others. One of the most extended habitats is the coarse bioclastic bottoms that are present mostly below 100 m and at the edge of the platform (Gofas et al. 2014), replacing the rhodolith beds. This is one of the most species-rich communities of the Alboran platform, with 415 species of invertebrates identified during the INDEMARES project (Gofas et al. 2014). The sea pens are particularly conspicuous and include the species *Veretillum cynomorium*, *Pennatula rubra* and *Virgularia mirabilis*. Other species present in this habitat are the sea cucumber *Parastichopus regalis*, the sea stars *Anseropoda placenta*, *Chaetaster longipes*, *Marginaster capreensis* and the small sea urchin *Genocidaris maculata*. The bioclastic bottoms are rich in crustaceans, with *Galathea intermedia*, *Inachus dorsettensis* and *Munida speciosa* as dominant species.

Among the studied marine fauna (Templado et al. 1986; Templado and Luque 1986; García Raso 1989; Templado et al. 1993; Templado et al. 2006), one of the best known groups is the molluscs (Salas and Luque 1986; Peñas et al. 2006) with more than 650 species listed for the Alboran Island, including some endemic species. The Ribbed Mediterranean Limpet, catalogued as “In Extinction Risk in the (CEE) has in this MPA one of its best populations, with ca. 950 individuals (Paracuellos et al. 2003; Moreno and Arroyo 2008; Arroyo et al. 2011; Junta de Andalucía 2014, 2018) (Fig. 4). The sponges and cnidarians are also noteworthy, with more than 198 species (Gofas et al. 2014; Sitjà and Maldonado 2014), and 76 species (of which 36 are anthozoans) respectively (César Megina and Pablo López, pers. com.). Among the cnidarians, in addition to the great diversity of gorgonians, important elements are the Star Coral (Vulnerable in CEE) (Fig. 4), the Red Coral, which was exploited for many years (Templado et al. 2006; Moreno 2008) or the rare and giant Whip Gorgonian (*Ellisella*

paraplexauroides) (LESRPE) (Mateo-Ramírez et al. 2020c), a unique Mediterranean relic from the Mauritanian-Senegalese Pleistocene interglacial expansion (Maldonado et al. 2013). Altogether, about 1500 species have been reported around the Alboran island (an exhaustive catalogue can be found in Templado et al. 2006), making the Marine Space of Alboran a biodiversity hot spot for the Alboran Sea and, therefore, the Mediterranean Sea (Barea-Azcón et al. 2008, Gofas et al. 2014).

In the Marine Reserve, outside the Integral Reserve, professional fishing is only permitted with the gears and equipment traditionally used such as bottom longline, trolling, fishing rods with live bait and purse seine for small pelagics, as well as recreational trolling. Bottom trawling is only allowed in the Fishing Reserve, and it represents the most important fisheries targeting deep water species such as the Blue and Red Shrimp (*Aristeus antennatus*). The number of authorized bottom trawling boats is currently 51 being the main base port Almería. One of the main threats of this MPA is the contamination derived from maritime traffic and possible oil spills. Although the emerged part of the island is guarded by a service of military forces, the MPA is very large and the limits are far from the coast, so illegal fishing is also a threat. Competences shared by regional and national governments should not affect the good management and conservation goals of the MPA.

4.3. Natural Park of Cabo de Gata-Níjar SPAMI and Parque Natural del Cabo de Gata-Níjar (Spain)

The Cabo de Gata (Gata Cape) and its surroundings (mountains, salt pans and seabeds) are located in the Almería province (south-eastern Spain) and they were declared as Natural Park (Parque Natural), with the name “Cabo de Gata-Níjar” by the Andalusian Government in 1987 (published in January 1988). It included more than 50 km of

coastline and 120 km² of marine area, constituting the first maritime-terrestrial protected area of Andalusia and of the northern Alboran Sea. The marine area spans one nautical mile from the coast along the 50 km of coastline, with maximum depths of ca. 90 m and six zones of maximum protection: Cabo de Gata, Los Genoveses, Punta de la Loma Pelada, Punta de la Polacra, Punta Javana and Mesa Roldán. The first Management Plan was published in 1994 (with an extension of the terrestrial part to the current 375 km²) and it was later on updated in 2008. This Natural Park is provided with management and scientific team, offices and equipment, and it has been a pioneer in many conservation activities of its rich natural heritage. For example, it has the only artificial conservation reef in Andalusia, installed between 1993 and 1994 to protect the integral reserve in front of Cabo de Gata (Guirado et al. 1997). In 1989, the salt pans area (Salinas) was included in the Ramsar Convention, and together with the adjacent mountains were classified IBA (ES216), and the entire MPA was then proposed SPA in 1992. In 1995, it was declared a Marine Reserve (only the external waters) by the Spanish Ministry of Agriculture, Fisheries and Food, and Biosphere Reserve by the UNESCO in 1997. In 2001 it was catalogued as a Geopark, entering in the European Geoparks Network in 2006 and in the UNESCO Global Geoparks Network in 2015. Moreover, it was declared SPAMI in 2001, following the BC. At the same time, this MPA was designated SCI (Cabo de Gata-Níjar, ES0000046) in 2001, which was further ratified in 2006 and 2009, and finally designated SAC (ES0000046) in 2012. Regarding that, this MPA is one of the most recognized coastal areas in Spain and it contains a significant number of protection figures.

This MPA nowadays spans over ca. 500 km², including the Gata Cape (Cabo de Gata) that is a first-order geographical accident (Fig. 5). The promontory “Charidemo”, as named by the ancients, is where the volcanic mountains of Cabo de Gata end and it is

characterized by an extensive outcrop of volcanic rocks mainly from the Calco alkaline series. They are constituted by a dominance of andesites and dacites Miocene in age (between 14 and 7.5 Ma) (Fernández Soler 1996). On the volcanic structures, especially at the North-eastern zone, there are important Messiniense reef limestone deposits (Villalobos 2003) from a period in which the Mediterranean Sea was warmer than today. The volcanic complex of Cabo de Gata is the largest in the SE of the Iberian Peninsula and is characterized by its diversity (Villalobos 2003).

In addition to the mountain and the succession of cliffs, the native vegetation includes numerous endemic species (Mota et al. 1997, 2011). This MPA has also extensive sandy beaches in the Bay of Almería, with dune areas and large shrub vegetation dominated by species of African origin such as *Ziziphus lotus* (Tirado 2009). Middle Pleistocene fossil beaches, with *Strombus* shells, also occur in specific areas (e.g. mouth of the seasonal river of the Amoladeras) (IGME 1983). The salt pans located close to Gata Cape, on an old natural coastal lagoon that was transformed by humans, are still of importance for the salt industry. They house a high biodiversity of birds, including the Black-winged Stilt (*Himantopus himantopus*), Pied Avocet (*Recurvirostra avosetta*), Kentish Plover (*Charadrius alexandrinus*) and the Greater Flamingo *Phoenicopterus roseus*, all included in Annex I of the BD.

A wide variety of habitats occurs in this MPA, with sedimentary bottoms (Habitat 1110 of the HD), hard bottoms (1170), seagrass meadows, mostly of *P. oceanica* (1120) and some marine caves (8330) (Fig. 5), among others. Regarding fauna, several cetaceans included in directives (Annex II - V of HD) and catalogues inhabit the waters of this MPA (e.g. the Fin Whale *Balaenoptera physalus*, the Common Dolphin *Delphinus delphis*, Orca *Orcinus orca*). Some threatened invertebrates are the vermetid *D. lebeche* (Vulnerable), Ribbed Mediterranean Limpet (Endangered), the Star Coral (Vulnerable)

(Fig. 5), Knobbed Triton (Vulnerable) and the Noble Pen Shell (Critically endangered) (Moreno and Barrajon Domenech 2008a; Moreno and De la Rosa 2008) (Mateo-Ramirez et al. 2020c). The latter, as already mentioned in Templado et al. (Chapter 11 of this volume), suffered a mass mortality event in 2016 (Vázquez-Luis et al. 2017) and no live specimens have been currently detected here and in the northern Alboran Sea (Junta de Andalucía 2018).

Regarding seagrass meadows, the most extensive ones are those of *P. oceanica* (Fig. 5), especially in the northern zone, with some meadows on hard bottoms in the southern zone (García Raso et al. 1992). *Cymodocea nodosa* meadows are also well represented in the MPA and there are specific sites with presence of *Zostera noltei* (Luque and Templado 2004). In the mesolittoral rock, Ribbed Mediterranean Limpet is nowadays scarce but it was probably more abundant in the past as witnessed by the archaeological sites in the mountains (Moreno 1992; Moreno and Arroyo 2008, Arroyo et al. 2011). One of the most characteristic formations of this MPA is the vermetid reefs of *D. lebeche* which are the most important ones in the northern Alboran Sea (García Raso et al. 1992; Moreno 2008; Junta de Andalucía 2017, 2018). In shallow rocky bottoms there is great diversity of photophilous algae, including different species of *Cystoseira* (e.g. *C. mediterranea*, *C. tamariscifolia*, etc.) as well as *Padina pavonica*, *Halopteris scoparia* and *Acetabularia acetabulum* (Ballesteros and Catalán 1984). Some zooxanthellate scleractinians, such as the Pillow Coral (*Cladocora caespitosa*) (Moreno et al. 2008a; Junta de Andalucía 2018) and *Oculina patagonica* (Zibrowius and Ramos 1983; Moreno 2010; Junta de Andalucía 2018) as well as the Rough Pen Shell (*Pinna rudis*) (Moreno and Barrajon Domenech 2008b) also inhabit these shallow rocky bottoms. In the sciaphilous rock walls, there is a wide diversity of macroalgae (*Peyssonnelia* spp., *Flabellia petiolata*, *Codium bursa*, *Cystoseira zosteroides* and

Dictyopteris polypodioides), bryozoans (e.g. *Myriapora truncata*) and tunicates (e.g. *Clavelina dellavallei*), among other invertebrates (García Raso et al. 1992; Ballesteros and Pinedo, 2004). Important precoralligenous habitats also occur in shallow areas (down to 6 m depth) with the presence of Star Coral colonies (García Raso et al. 1992), a species that has its main Spanish populations in the Alboran Sea westwards of Gata Cape (Moreno et al. 2008b) and the Purple Sea Star (*Ophidiaster ophidianus*) (Moreno and Pérez Ruzafa 2008). Interesting rhodolith beds occur in the MPA (Luque and Templado 2004), but coralligenous communities are not well developed and are characterized by some hardy gorgonians and small kelp such as *Phyllariopsis purpurascens*, which is just occasional in some years (Moreno et al. 2005). There is a good knowledge on the marine flora and fauna of this MPA, at least regarding mega and macrofauna, and it can be considered a biodiversity hot spot for the Mediterranean Sea (Barea-Azcón et al. 2008). García Raso et al. (1992) listed more than 1400 species, later on updated and increased by Luque et al. (1999) and Moreno (2003). In summary, ca. 265 species of macroalgae (168 red algal species), more than 50 sponges, 60 cnidarians, 5 ctenophores, ca. 175 polychaete annelids, ca. 375 molluscs, 120 crustaceans, 17 lophophorians, 32 echinoderms, 46 tunicates, more than 150 fish, two marine turtles, ca. 30 sea birds (Guirado et al. 1997) and at least 8 cetaceans have been recorded so far in this MPA. Unfortunately, the monk seal *Monachus monachus* has not been detected since the mid-twentieth century when it was considered very rare. Nevertheless, it certainly lived in the area because several places were named in relation to the monk seals (e.g. Arrecife de las sirenas-Sirens reef, Torre y Colina de los Lobos - hill and tower of the Wolves).

The ichthyofauna of the artificial reefs installed in the integral reserve has been monitored for more than 20 years in summer and winter. An increase of 72 fish species

has been detected, as well as an evolution of the typical soft bottom fish assemblages (dominating *Pagellus acarne* and *Mullus surmuletus*) to more stable and typical hard bottom fish assemblages with large predators (e.g. Dusky Grouper and Goldblotch Grouper *E. costae*), and some pelagic species (e.g. *Seriola dumerili*) that benefit from the reef environment (Moreno et al. 2006). Several fishing nets hooked on the reefs were removed during monitoring, confirming the effectiveness of this passive method against bottom trawling (Junta de Andalucía, 2015) (Fig. 5). Similar monitoring was carried out for shallow rocky bottoms inside and outside the maximum protection areas for testing the “reserve effect” in coordination with other MPAs of South-eastern Spain (Moreno 1995; García-Charton et al. 2004). In all these MPAs, the Dusky Grouper was more abundant within maximum protection areas than outside them, and smaller serranids than this grouper (e.g. Goldblotch Grouper, *Serranus cabrilla*, *Serranus scriba*) were more abundant in Cabo de Gata-Níjar than in other MPAs (García Charton et al. 2004).

The Andalusian Administration has also done big efforts for increasing the knowledge and conservation of seagrass meadows of this MPA, with projects for mapping *P. oceanica* meadows of the coasts along Almería (the largest meadows in the Andalusian coasts) in 1995-1996 by the Universidad Autónoma of Madrid (Luque et al. 2004). Recently, further mapping was carried out with the EU Life+ *Posidonia* Andalucía project between 2011 and 2016 (Mendoza et al. 2014; Arroyo et al. 2015). The project also carried out numerous divulgation actions and promoted the definitive establishment of a monitoring network for *P. oceanica* (POSIMED) with 5 fixed sampling stations (3 of them for demographic studies) in this MPA (Junta de Andalucía 2017, 2018). Recently, the Life Blue Natura project, is studying the CO₂ stock of *P. oceanica* meadows, with one station in Agua Amarga. Here, a corer of more than one metre was

retrieved in the deep meadows (-18 m) and resulted in ages of more than 3000 years BP (Mateo et al. 2018).

The socio-economic importance of this MPA is mainly related to the appreciation of its natural values by tourism, sport and recreational activities (e.g. sun bathing beaches, swimming, scuba diving). In addition to the natural and landscape values, the MPA contains interesting and diverse historical (Roman salting factories, watchtowers and castles, etc.) and cultural heritages (cottages, waterwheels, abandoned mines, etc.), as well as numerous artisanal activities, such as traditional crops, fisheries and salt extraction in the salt pans (Villalobos et al. 2004). Regarding fisheries there is a fleet of 30 artisanal vessels and 15 purse-seine boats. The main artisanal gears used are gillnets targeting European Hake (*Merluccius merluccius*), Cuttlefish (*Sepia officinalis*), mullets (*Mullus* sp.) or Spiny Lobster (*Palinurus elephas*), “moruna” that is similar to a small “almadraba” targeting small tunas such as Greater Amberjack (*Seriola dumerili*), Atlantic Bonito (*Sarda sarda*) or Little Tunny (*Euthynnus alletteratus*) and pots targeting Common Octopus (*Octopus vulgaris*) and Soldier Striped Shrimps (*Plesionika edwardsii*). Recreational fishing from the coast or using a boat is subjected to different restrictions. The authorized recreational modalities from the boat are “chambel” or “volantín” to be used outside the limit of the *P. oceanica* meadows, and surface trolling, being subject to a series of restrictions (e.g. number of gears per fisherman, catch limits) and some species are prohibited with this modality such as Dusky and Goldblotch groupers, Shi Drum (*Umbrina cirrosa*), Meagres (*Sciaena umbra* / *Argyrosomus regius*), all types of commercial crustaceans and molluscs except the Common Squid (*Loligo vulgaris*). Bottom trawling and spearfishing are not allowed in the entire MPA.

The semi-arid climate of Almería, one of the most arid ones in Europe (200 mm of annual rainfall) (Guirado et al. 1994), probably has not allowed important human settlements. In addition to the oceanographic conditions, this may have favoured the transparency of the seawater and the good status of its seabeds. Among the notable threats, it is possible to highlight the maritime traffic that passes very close to the Gata Cape, the increasing tourism, the arrival of invasive alien species (*Caulerpa cylindracea* in 2012; Junta de Andalucía 2012) and poaching. A greater coordination between national, regional and local administrations is desirable for improving the management of this MPA.

4.4. Sea bottoms of the Levante of Almería SPAMI and Terreros and Negra Islands Natural Monument (Spain)

This MPA is located between Almería and Murcia provinces (adjacent area to the north-eastern Alboran Sea). It was proposed as SIC in 1997 and approved in 2006 with the name “Fondos Marinos del Levante Almeriense” (Sea bottoms of the Levante of Almería) (ES6110010) with an area of 63.13 km². In 2001, it was also approved as SPAMI, but the limits were modified several times between 2009 and 2015, partly towards the coastline, until reaching 106.92 km². In 2016, it was declared SAC (ES6110010), spanning 45 km from Carboneras village to the border with the Murcia province, and a depth range from the coastline to ca. 200 m. A small extension of its southern limit (0.5 km²) was proposed by the Life+ *Posidonia* Andalucía Project in order to include the *C. nodosa* meadow located outside the MPA (Aranda and Otero 2014). Within this MPA, there is also one Natural Monument of biotic character called “Terreros Island and Isla Negra” (Fig. 6), which was declared in 2001 by Andalusian Government. This Natural Monument only protects the emerging part of these two volcanic islets that harbour interesting sea bird colonies. The Natural Monument

declaration includes basic management criteria and a list of unsupported activities (Castro et al. 2003). Previous to the declaration of this area as SPA (ES0000507) “Espacio marino de los Islotes Litorales de Murcia y Almería” (123.35 km²) in 2014, the Islands Negra and Terreros (ca. 0.17 km², Almería) was included inside the IBA (ES170), which are formed by these and the islet Las Palomas (Murcia). The islet of Terreros harbours one of the few breeding colonies in the Mediterranean Sea of the Atlantic Cory’s Shearwater (*Calonectris borealis*), with 30-35 breeding pairs, and both islets host breeding colonies of European Storm-Petrels (*Hydrobates pelagicus*); a minimum of 100 breeding pairs in the islet of Las Palomas, and a lower but unknown population in Terreros (Arcos et al. 2009; Reyes-González and González-Solis 2016) (Fig. 6).

Seven marine habitats are represented in the MPA, including *P. oceanica* beds (Habitat 1120 of the HD), caves (8330), sandbanks (1110) or reefs (1170), among others (Fig. 6) (Mateo-Ramírez et al. 2020b). Two clearly differentiated zones can be distinguished. In the northern zone (Almanzora River towards Murcia province), the seabed has extensive and vigorous seagrass meadows (Luque and Templado 2004), especially of *P. oceanica* (Moreno et al. 2004a; Arroyo et al. 2015) (Fig. 6). Further south, the stretch until reaching Villaricos runs parallel to the Almagrera mountains range that is composed of shales and other minerals, and where there was a large mining activity of lead and silver (Navarro et al. 1997). From the south of the Almanzora River to Carboneras, the seabed is predominantly sedimentary with different sediment types, including areas of fine sand, others of gravel and also of mud, as in the canyon in front of Garrucha where they exceed 200 m depth. In this southern area *C. nodosa* meadows are well represented (Moreno and Guirado 2003; Moreno et al. 2004b; Arroyo et al. 2015).

From 1995 to 2016 a high number of studies were carried out in this MPA, from *P. oceanica* mapping and demographic studies to faunistic inventories (e.g. Luque et al. 2004; Life+ *Posidonia* Andalucía Project 2011-2016). Thanks to the Life+ *Posidonia* Andalucía Project, six stations of *P. oceanica* were monitored within the POSIMED Network and eleven ecological buoys were installed along scuba diving areas and around the island of Terreros to avoid anchoring on the meadows (Mendoza et al. 2014).

The protected species of this MPA are similar to those of Cabo de Gata-Níjar MPA. Nevertheless, the best population of the Noble Pen Shell for the whole Andalusian coast lived on *P. oceanica* meadows of this MPA, and it was monitored annually by the Marine Environment Management program of the Andalusian Administration until its mass mortality in 2016 (Moreno and Barraión Domenech 2008a; Junta de Andalucía 2015; Vázquez-Luis et al. 2017). In the northern area between San Juan de los Terreros and Villaricos there are reefs of the vermetid *D. lebeche* (Vulnerable), which are monitored annually (Junta de Andalucía 2018). There are also several rocky areas (from ca 5-30 m depth) that are very visited by sports divers, such as El Calón, Loza del Payo and El Cerro. The Hatpin Urchin (Annex IV of HD) also showed in these heterogeneous rocky bottoms their densest known population for the Andalusian coasts (Junta de Andalucía 2014) (Mateo-Ramírez et al. 2020c). Other species inhabiting these rocky bottoms are the sciaphilic algae *Halimeda tuna* and *D. polypodioides*, together with the bryozoan Ross Coral (*Pentapora fascialis*) (Fig. 6). In these submerged rocky elevations there are some cracks and caves. The most important cave is known as La Catedral whose roofs and walls are upholstered with sponges such as *Oscarella lobularis* and *Chondrosia reniformis*, corals such as *Madracis pharensis* and

Leptosammia pruvoti and the Smooth Starfish (*Hacelia attenuata*) catalogued as Vulnerable (Mateo-Ramírez et al. 2020c).

The main threats of this MPA are the increase in tourism, maritime traffic (very intense near Garrucha), illegal trawling, pollution, invasive alien species and the absence of regulations for underwater fishing. Several housing developments have been built mainly on the coast of Vera, Garrucha and Mojácar, but also in San Juan de Los Terreros. In spite of the coastal population increase and the associated sewage, the main contamination threat is the discharge of the chemical plant Deretil northwards of Villaricos. This discharge occurs on the shore and has affected the seabed, mainly the *P. oceanica* meadows down to ca. 10 m depth, leaving large areas of “dead matte” (Moreno et al. 1999, 2001; Arroyo et al. 2015). In 2008, the invasive algae *C. cylindracea* (previously known as *C. racemosa*) was detected near the island of Terreros at 17 m depth, representing the first record for the Andalusian coasts (Moreno 2010). In a short time it extended extensively and covered ca. 1.2 km² in 2009, and nowadays it is mainly affecting rhodolith beds (15-30 m depth) (Junta de Andalucía 2014). Other invasive species are also abundant in the area, such as the crab *Percnon gibbesi* (since 2006) and the seaweed *Lophocladia lallemandii* (in Cocedores since 2012) (Junta de Andalucía 2014). The scleractinian *O. patagonica*, of an invasive nature, is very abundant locally in the southern area of this MPA, mainly in port areas (Junta de Andalucía 2018) but also in shallow rocky bottoms (0-3 m) (Serrano et al. 2012).

4.5. Al-Hoceima National Park SPAMI and collateral figures (Morocco)

The Al-Hoceima National Park (Parc National d’Al-Hoceima) was declared in 2004 by the High Commission for Water & Forests. It is the main MPA and the only National Park in the Mediterranean part of Morocco. Due to its significant biodiversity, comparable to that of the main hot spots of the Mediterranean Sea, it was also declared

as a SPAMI in 2009. This MPA is located in northern Morocco, close to the city of Al Hoceima, and covers an area of 480 km², with a terrestrial part limited to the west by Mestassa valley and to the east by the Rhis River. The maritime area extends ca 200 km² over approximately 40 km of coastline and a depth range from the coastline to ca. 200 m. This MPA includes a Marine Natural Resources Management Area, a Strict Nature Reserve and a Natural Sanctuary.

The coastline is dominated by steep cliffs (more than 60 m high) of the limestone ridge (Khouakhi et al. 2013) that have significant gravitational instabilities at the top, and at times are spaced by small coves and sandy bays as well as some islets (Fig.7). Due to the erosion caused by the intense wave action, there are caves and shallow underwater openings that can exceed 60 m in length. The beaches are relatively rare and not very extensive, and they mostly occur in protected areas of bays such as the beaches of Cebadilla or Tala Youssef, or can form isthmus such as those of Cala-Iris and Badès. The rest of the coast is mainly conformed of pebble and gravel beaches with some coarse sand. The sublittoral domain is characterized by hard bottoms, made of blocks of fallen rocks, and also by soft bottoms, mostly with medium and fine sands, and with fairly gentle slopes. These singular geological features provide a wide environmental variety of great geological and biological value, where several types of marine habitats are present harbouring a high biodiversity (Mateo-Ramírez et al. 2020b).

The geomorphology of the coast, with inaccessible steep cliffs, and the high fish richness and productivity constitute favourable conditions for some individuals of the Mediterranean monk seal (Tunési et al. 2003), which is included as Critically Endangered in the IUCN Red List (Mateo-Ramírez et al. 2020c). It is also possible to spot some cetaceans of conservation interest (i.e. included in Annex IV of the HD) such as the Common Dolphin, the Stripped Dolphin and the Bottle-nosed Dolphin. It is also

an important area for the Loggerhead Turtle (*Caretta caretta*) and more rarely for the Leatherback Turtle (*Dermochelys coriacea*) or the Green Turtle (*Chelonia mydas*) (UICN 2012b) (Mateo-Ramírez et al. 2020c).

This SPAMI shows a high diversity of seabirds, favoured by the presence of rocky cliffs, caves and islets. It is remarkable the presence of the only breeding nucleus of Ospreys in Morocco, with a population of 20-25 adult birds and, at least, 6 breeding pairs (Monti et al. 2013). The Mediterranean population of Osprey shows an unfavourable conservation status and currently holds less than 100 breeding pairs. In Al-Hoceima National Park a strong decrease in population size has occurred during the last decades, from 14-16 pairs in the 1980s to only 6 in 2012-2013 (Berthon and Berthon 1984; Hodgkins and Beaubrun 1990; Monti et al. 2013), being still exposed to local extinction risk. Other species of interest in the area are the Audouin's Gull, the Scopoli's Shearwater, the Mediterranean subspecies of the European Shag (*Phalacrocorax aristotelis desmarestii*) (Fig. 8), the Lesser Crested Tern (*Thalasseus bengalensis*) during its migration, and the Sandwich Tern during winter.

The marine habitats of this MPA were recently explored in the framework of the MedMPAnet Project by Espinosa et al. (2015). Ten different habitats were detected, including some key conservation habitats such as seagrass meadows, dark and semi dark cave communities, rhodolith beds and coralligenous assemblages. Some of these habitats are similar to those included in Annex I of the HD: Sandbanks which are slightly covered by sea water all the time (Habitat 1110), Reefs (1170), Vegetated sea cliffs of the Mediterranean coasts with endemic *Limonium* spp. (1240), with *Limonium asparagoides* (endemic to Morocco and Algeria), and Submerged or partially submerged sea caves (8330) (Mateo-Ramírez et al. 2020b). The marine vegetation displays a high diversity with more than 300 species reported, including kelps (*S.*

polyschides, *L. ochroleuca*, *P. purpurascens*, *P. brevipes*) (UNEP-MAP-RAC/SPA. 2014; Moussa et al. 2018). On the coastal rocks some red algae, such as *Lithophyllum incrustans*, build a formation called "*Lithophyllum* sidewalk" together with other species of corallinaceae like *Mesophyllum lichenoides* (Moussa et al. 2018). In high hydrodynamic deep areas, some free calcareous red algae form rhodolith beds which shelter a great variety of fauna and flora. The *C. nodosa* meadows, included in the Annex I of the Bern Convention and in the Annex II of the BC, are also abundant in this MPA.

The marine fauna is very diverse and includes most of the Mediterranean species of conservation importance. For example, the Ribbed Mediterranean Limpet displays populations in Cala Iris that are important for conservation (Bazairi et al. 2004) (Fig. 7). There are also formations of the vermetid *D. lebeche* (Fig. 7) and the coralligenous communities are well developed with coral such as the Star and Red Corals as well as gorgonians as *Eunicella cavalonii*, the White Sea Fan (*Eunicella singularis*) and the Violescent Sea-whip (UICN 2012a; MedPAN and SPA/RAC, 2019). The ichthyological diversity is high, with more than 100 species, some of them of commercial interest such as the Common Dentex (*Dentex dentex*), Redbanded Seabream (*Pagrus auriga*) as well as several species of groupers including the Dusky Grouper (UICN 2012a) (Mateo-Ramírez et al. 2020c).

Al-Hoceima National Park has a great potential for tourism activities and the human development has slowed down in a large part of its coastal area, due to ecological and environmental constrains. Tourism represents an impact on the environment and on the local people culture, who may be threatened by uncontrolled housing developments, including massive tourist developments. An ethical debate is currently taking into account the need for preserving the natural and cultural resources of this MPA or,

conversely, for promoting the economic development of the local population. Fishing can be considered as one of the main economic activities, with two main ports (Al-Hoceima port and Cala-Iris port) and seven artisanal fishing sites (Torrès, Badès, Taoussert, Tikket, Boussekour, Inouaren and Adouz). The fishing fleet is mainly composed of trawlers, sardine boats, longliners and boats, and the fishery resources exploited are demersal species, such as the Red Mullet (*Mullus barbatus barbatus*), small and large pelagics such as European Pilchard (*Sardina pilchardus*) and Swordfish (*Xiphias gladius*) and small tuna, such as the Atlantic Bonito (*Sarda sarda*). After a socio-economic analysis of the sustainability of the fishing activity carried out in 2011, fishermen of this MPA have proposed management measures (e.g. a zonation of the marine area close to the coast) in order to reduce illegal fishing activities.

4.6. Habibas Islands SPAMI and collateral figures (Algeria)

In 2005, several sites (Banc des Kabyles, Habibas Islands, Rachgoun Island and Cap de Garde) were listed as potential MPAs in Algeria (UNEP 2005). Only two of them were designated as SPAMIs, Banc des Kabyles and Habibas Islands (*Les îles Habibas*) being the later the one located in the Alboran Sea. Habibas Islands consist of two rocky islands lying 12 km west of the Algerian coastline just below the headland known as “Les Andalouses” (which itself lies 45 km west of Oran). The larger island is called “Gharbia” and reaches 103 m in height. The smaller and more easterly island is called “Charguia” and reaches no more than 25 m in height. They were firstly declared a Marine Nature Reserve in 2003 and SPAMI at the Seventh Meeting of National Focal Points for SPAs of 2005, covering ca. 26 km² and a depth range between the coastline and 485m depth. Habibas Islands represent the first MPA, and also the first SPAMI, established in Algeria.

Habibas Islands are of volcanic origin and they belong to the Sahel d'Oran volcanic complex that has been characterized by rocks of andesitic to rhyolitic composition of the Calcoalkaline series and Tortonian age (Bellon et al. 1984).

This MPA was also internationally recognised as IBA in 2001. Under the tutelage of the Commissariat National du Littoral (CNL), this MPA has benefited since its creation from a number of activities implemented in the framework of international collaborations and is currently co-managed by the CNL in collaboration with the local NGO "Barbarous". The management plan for the Habibas Islands was finalised in 2013 as part of the "Development support of the CNL" project by the Conservatoire du Littoral. Its implementation was deferred to 2015 with 5 year management objectives focused on conservation and development (MedPan Web page visited the 06022020) <http://medpan.org/seven-new-medpan-small-projects-on-track-in-the-mediterranean/>.

Different and interesting bird species use this MPA as a breeding location, including the Audouin's and Yellow-legged Gulls, Scopoli's Shearwater, the Mediterranean subspecies of the European Shag, Osprey and Eleonora's Falcon (*Falco eleonora*) (Fig. 8) (Mateo-Ramírez et al. 2020c). The habitat Halonitrophilic thickets (*Pegano-Salsolitea*) (similar to the Habitat 1430 of the HD) is well represented in the Habibas Island with important population of plants such as *Salsola longifolia* or *Withania frutescens*.

The sublittoral part of this MPA hosts a high diversity of habitats and species. One of the most abundant habitats are the rocky bottoms (similar to Habitat 1170 - Reefs of the HD) in which several species included in various conventions and annexes thrive, such as the Ribbed Mediterranean Limpet with populations exhibiting high densities, a well-structured size distribution and high reproductive output in mesolittoral bottoms (Espinosa et al. 2014). Other protected species are the macroalgae *Cystoseira* spp. (C.

zosteroides and *C. amentacea*), some cnidarians such as the Star Coral in the infralittoral, echinoderms such as the Purple Sea Star, molluscs such as the Knobbed Triton or the Noble Pen Shell (probably extinct at present) and large fishes such as the Dusky Grouper at larger depths (Bache et al. 2007) (Mateo-Ramírez et al. 2020c). Coralligenous communities are the most abundant at the circalittoral zone, with species of interest for conservation, such as the gorgonians Violescent Sea-whip, the White Sea Fan or *Leptogorgia sarmentosa*. The second habitat in order of importance is similar to the Sandbanks which are slightly covered by sea water all the time of the HD (Habitat 1110), and displays different kinds of bottoms, such as rhodolith beds or detritic bottoms with sea pens and soft bottom octocorals (*Paralcyonium spinulosum*, *V. cynomorium*) (Bachet et al. 2007). It is remarkable the absence of *P. oceanica*, which is however present on the continent towards the west until Melilla (Bachet et al. 2007).

One of the socio-economic benefits of the MPA is recreational diving, which may also represent a threat, because of the potential impact on vulnerable and slow growing habitats such as the gorgonian aggregations. Nevertheless, the main threats of this MPA are related to fisheries and mainly to underwater fishing. Bachet et al. (2007) presented some evidence of this, the observations of school of commercial fish species with small size as well as their elusive behaviour. This is confirmed by old photos and testimonies of fishing carried out several decades ago, which indicate a great abundance of fish (grouper in particular) and large crustaceans. The increasing presence of invasive species such as the macroalgae *Asparagopsis armata*, *Asparagopsis taxiformis* and *Codium fragile* or the scleractinian *O. patagonica* represents other threats to these islands (Bachet et al. 2007).

5. Other Marine Protected Areas and Key Biodiversity Areas from the northern Alboran Sea and adjacent areas

Different MPAs and KBAs located in the northern Alboran Sea and adjacent areas are presented from west to east direction, including remarks on their location, protection figure status, natural heritage, socio-economic importance and main threats.

5.1. Parque Natural del Estrecho & SAC (Spain)

Situated in the north-western limit of the Alboran Sea the “Parque Natural del Estrecho” SAC (Strait Natural Park) (ES0000337) was proposed as Nature Park (Parque Natural) by the Andalusian Government and as SCI in 2003. Finally it was declared SCI in July 2006 and SAC in September 2012. The Intercontinental Biosphere Reserve of the Mediterranean, declared in 2006, includes a marine strip of this Natural Park. It is located on the northern part of the Strait of Gibraltar between Getares Cove (westwards of Algeciras Bay) and Gracia Cape (westwards of Bolonia Bay), with a discontinuity in front of Tarifa harbour. It covers an area of ca. 192 km² of which 96 km² are located in the marine environment, and a depth range from the coastline to ca. 300 m. The Strait of Gibraltar is characterized on both banks by the Flysch Complex, which are usually made up of alternating marls and/or shales, gray limestones and micaceous sandstones, deposited in turbidite systems, their age varies from the upper Cretaceous to the lower Miocene (Didon et al. 1973; Balanya et al. 2007). This stratigraphical pattern is reflected in the geomorphology of both terrestrial and marine areas, where the sandstone layers are much better marked in the relief. The MPA is characterized by large areas of rocky outcrops increasing towards Algeciras where the slope is steepest and sandy sediments arranged as large bottom forms generated by the wave and current action (Maldonado et al. 2003).

The main marine-related habitats included in Annex I of HD are Coastal lagoons (Habitat 1150), Reefs (1170) and Sandbanks which are slightly covered by sea water all the time (1110) (Mateo-Ramírez et al. 2020b). Nevertheless, the SAC contains a total of 25 coastal and terrestrial habitats included in the HD, with some of them interconnected with the marine system. This MPA also has an important natural heritage and a high biodiversity, with more than 1900 species of plants and animals, including endemic species and new species that have been recently described. Some large species are included in Annex II of the HD such as the Loggerhead Turtle (*Caretta caretta*), the Leatherback (*Dermochelys coriacea*), the Bottle-nosed Dolphin (*Tursiops truncatus*) (Fig. 9) and the Common Porpoise (*Phocaena phocaena*), with some of them frequently detected in the MPA because of its strategic position between two continents (Africa and Europe) and two basins (Atlantic Ocean and Mediterranean Sea). Other common cetaceans of this MPA are the Long-finned Pilot Whale (*Globicephala melas*) (Fig. 9), the Common Dolphin (*Delphinus delphis*), the Striped Dolphin (*Stenella coeruleoalba*), together with larger species such as the Sperm Whale (*Physeter macrocephalus*) and the Orca (*Orcinus orca*). The occurrence of Orca populations in this MPA is apparently related to the migration of one of their main prey, Bluefin Tuna (*Thunnus thynnus*), towards the Mediterranean Sea (Esteban et al. 2016). Moreover, a good variety of seabird species occurs in this MPA such as the Scopoli's and Cory's Shearwaters (*Calonectris diomedea* and *C. borealis*), Northern Gannet (*Morus bassanus*), Sandwich Tern (*Stenella sandvicensis*), the Great Skua (*Stercorarius skua*), the Balearic Shearwater (*Puffinus mauretanicus*) and the European Storm Petrel (*Hydrobates pelagicus*) (Mateo-Ramírez et al. 2020c). In the mainland, it is also possible to spot migratory species, especially soaring birds, that include this MPA along their migratory routes towards Africa such as the White Stork (*Ciconia ciconia*), the Black Kite (*Milvus*

migrans), the European Honey Buzzard (*Pernis apivorus*), the Booted Eagle (*Hieraaetus pennatus*), and the Short-toed Eagle (*Circaetus gallicus*), among others. Other important birds occurring in the terrestrial part of this MPA are the Spanish imperial eagles (*Aquila adalberti*), the Egyptian Vultures (*Neophron percnopterus*), and the Bald Ibis (*Geronticus eremita*), a critically endangered bird species that disappeared from Europe during the 16th century, but has been introduced in specific Spanish locations of the Strait of Gibraltar at the beginning of the 21st century.

In the intertidal and shallow infralittoral rocks, some protected species display important populations such as the Ribbed Mediterranean Limpet (*Patella ferruginea*) and the Saffian Limpet (*Cymbula safiana*; more frequent in the eastern part of the MPA), the vermetid *Dendropoma lebeche* (more frequent in the western part) as well as some endemism of the Strait of Gibraltar such as the nassarid *Nassarius tingitanus* and the cerithiid *Cassidula abylensis* (Gofas 1998; Barea-Azcón et al. 2008; Ruiz-Giráldez et al. 2011) (Mateo-Ramírez et al. 2020c). In some infralittoral hard bottoms (e.g. Tarifa Island), extensive seaweed meadows occur, including those with large kelps exposed to strong bottom currents (e.g. *Saccorhiza polyschides*, *Laminaria ochroleuca* and *Phyllariopsis* spp.) (Fig. 9), however recent observations have indicated a strong decline of these meadows. In the infralittoral hard bottoms, the presence of the Knobbed Triton (*Charonia lampas*) and the Star Coral (*Astroides calycularis*) on the rocky bottoms, represent indicators of a good environmental quality. Seagrass beds conformed by *Cymodocea nodosa* occur in specific areas with soft bottoms of this MPA (e.g. Tarifa), but the mediterranean *Posidonia oceanica* does not occur in this and other parts of the northern Strait of Gibraltar.

The socio-economic importance of the MPA is mainly related to tourism activities (e.g. bird watching, whale watching, cultural sites - i.e. the ancient Roman city of Baelo

Claudia), sports (e.g. windsurf, kite surf, scuba-diving) and artisanal fisheries. The main fishing modalities are small gears and purse seine, from the inshore fleets of Tarifa and Algeciras. There is a specific fishery for the Blackspot Seabream (*Pagellus bogaraveo*) being the most caught species in the area, mainly by the Tarifa fleet among the Spanish one. Other commercial species caught are: Horse Mackerel (*Trachurus* spp), Blackbelly Rosefish (*Helicolenus dactylopterus*), Dusky Grouper (*Epinephelus marginatus*), Bluefin Tuna (*Thunnus thynnus*), and Black Sea Bream (*Brama brama*). There is also an important seafood fishing activity, carried out mainly in the intertidal area, and therefore on foot. In addition sport fishing from boats and from the coast is very widespread in the area.

The main threats include marine pollution and eutrophication, maritime traffic, electric lines and wind turbines deployment (bird collisions), development of human infrastructures (mainly beach bars, pathways, port expansion). Some invasive species such as the brown algae *Rugulopteryx okamurae* have recently colonized massively the rocky bottoms down to 35 m depth and have displaced other photophilic seaweeds (García-Gómez et al. 2020). This seaweed was detected in 2015 for the first time in Ceuta, south of the Strait of Gibraltar, probably from ballast waters of a ship from Asian origin (Rosas Guerrero et al. 2018; Baeza 2019). Since then it has shown a surprising establishment and dispersion that has almost completely displaced the local biota, producing also important negative effects on the local fishermen. Later on, this brown algae has expanded massively on subtidal illuminated marine hard-bottoms within the strait of Gibraltar and the adjacent Alboran Sea in the past two years, producing big impacts and economic losses to the fishermen from the area as well as serious impacts on the benthic communities previously established, accumulation of hundreds of tons of seaweed in nearby beaches and wrack zones and hooks on fishing nets (Junta de

Andalucía 2018; García-Gómez et al. 2020). García-Gomez et al. (2020) described a possible linkage with global warming. On December 20, 2019, the Sub-Directorate General for Biodiversity and Natural Environment received the proposal for cataloguing *R. okamurae* as an invasive species, which includes the risk analysis prepared by the University of Málaga. Another invasive species has been recently detected, *Caulerpa cylindracea*, which probably arrived through maritime traffic between Ceuta and Tarifa (Pellón et al. 2017). Although the invasion is incipient, the species should be considered successfully established, because of its wide spread in this MPA (Pellón et al. 2017).

5.2. Paraje Natural de Marismas del Río Palmones and SAC - Fondos Marinos Marismas del Río Palmones SAC (Spain)

The Paraje Natural (Natural Area) Marismas del Río Palmones (Palmones River Salt marshes) was firstly declared a Natural Area (Paraje Natural) by the Andalusian Government in 1989. Later on it was proposed as SCI in January 2001, declared as SCI in July 2006 and SAC (ES6120006) in November 2013. It is located on the salt marshes area of Palmones River within Algeciras Bay (northern Strait of Gibraltar) (Fig. 10), and it covers an area of 1 km² of fluvial, estuarine and terrestrial habitats, with a depth range from the coastline down to ca. 4 m. This SAC is connected with another SAC known as Fondos Marinos Marismas del Río Palmones (Marine bottoms of Palmones River Salt marshes) (ES6120033), which was proposed as SCI in May 2007, declared SCI in December 2008 and SAC in August 2015. This last SAC is connected to the previous one, and covers an area of 1 km² of marine habitats with a depth range from the coastline to ca. 30 m. The mouth of the Palmones River is characterized by a salt marsh area consisting of two levels, high and low, bounded to the north-western by a system of coalescent alluvial fans, to the east by a system of fossil dunes and to the

south by another system of active dunes and the littoral barrier itself (IGME 2012a). In the marine part, outcrops of the Flysch Complex to the east of the Guadarranque river mouth stand out. The main marine-related habitats included in Annex I of the HD are Estuaries (Habitat 1130), Mudflats and sandflats not covered by seawater at low tide (1140) and Sandbanks which are slightly covered by sea water all the time (1110) (Mateo-Ramírez et al. 2020b). Nevertheless, the first MPA also contains a wide variety of terrestrial habitats that are interconnected with the salt marshes.

These 2 MPAs were proposed because of the presence of more than 40 bird species, as well as 2 mammals (Eurasian Otter *Lutra lutra* and the Bottle-Nosed Dolphin) (Fig. 10) and 1 reptile (the Loggerhead Turtle) included in Annex II of the HD, among other species. Due to its strategic geographic position it is an important area for migratory species, mostly shorebirds and herons, but also raptors and passerines. During winter it is frequently visited by species such as the White Stork, the Osprey (Fig. 10) and ducks, among other species (Mateo-Ramírez et al. 2020c).

These MPAs represent one of the few coastal wetlands that still retain the characteristics of the original salt marshes and estuarine areas and the ecological values associated with these natural habitats (Habitats 1130, 1140, 1320, 1410, 1420 of the HD). The Marismas del Río Palmones has a strategic location for migratory birds that cross the Strait of Gibraltar, as a resting, feeding and even reproductive area. Different marine species also take advantage of the ecological characteristics of this space to develop basic functions of its life cycle, such as spawning and feeding. In the intertidal zone it is possible to spot meadows of the small seagrass *Zostera noltei* (Fig. 10), which displays a very limited distribution in the Mediterranean Sea and experienced a strong regression in the last decades. The dune habitat plays an important role in the stabilization of the wetland, housing flora of interest at regional level such as the Cat's Ear (*Hypochaeris*

salzmanniana), which occurs in the nesting habitat of the Kentish Plover (*Charadrius alexandrinus*). The strictly marine SAC (Fondos Marinos Marismas del Río Palmones) plays an important role as a connecting element between the fluvial-estuarine and marine environments, for physical and biological continuity and ecological processes. The ecological connectivity of the fluvial-estuarine-marine system provided by the 2 MPAs is of importance for conservation of different fish species that frequent the marshes and/or the river, either as a refuge, breeding and nursery.

The socio-economic importance is related to tourism activities (e.g. bird watching), sport (e.g. windsurf, kite surf, recreational fishing) and artisanal fisheries mainly targeting some fish species (e.g. *Anguilla anguilla*, *Sparus aurata*) as well as estuarine bivalves such as the Cockle (*Cerastoderma edule*) and other clams (*Ruditapes decussatus*, *Ruditapes philippinarum*, *Venerupis aureus*). The main threats include marine pollution because the proximity of an industrial area and eutrophication, electric lines (bird collisions) and invasive species such as the brown seaweed *R. okamurai* (Junta de Andalucía 2018).

5.3. Estrecho Oriental SAC (Spain)

The Estrecho Oriental SAC (eastern Strait of Gibraltar) (ES6120032) was originally proposed SCI in May 2007, approved SCI in February 2009 and designated SAC in December 2012. The SAC is located in the north-eastern part of the Strait of Gibraltar, bordering the Gibraltar rock and La Línea de la Concepción (Cádiz), covering an area of 236 km² and a depth range between the coastline to ca. 880 m. The main geomorphological features of this SAC include two submarine canyons (Algeciras and La Línea) characterized by their proximity to the coastline. The Algeciras submarine canyon has a complex geomorphology with three sectors (headwall, middle course and

distal sectors) where the different dominant sedimentary processes reflect a recent sedimentary dynamics along the system (Vázquez et al. 2017). The erosive processes dominate in the middle and distal sector (especially in the incisive gullies and crescent-shaped bed forms) indicating sediment reworking caused probably by the interaction of the Mediterranean water mass. La Línea turbidite system comprises four architectural elements (canyon, channel, overbank and lobe deposits) that have developed from the continental shelf (15 m depth) towards the basin (835 m depth) (Palomino et al. 2019). Another interesting geomorphological structure present in this area is a pockmark field detected in the deepest part of the SAC (Vázquez et al. 2015b).

The abundance and richness of species is largely influenced by the strong currents and upwellings that are characteristic of the Strait of Gibraltar. This SAC was originally proposed because of the presence of four types of natural habitats included in Annex I of the HD: Sandbanks which are slightly covered by sea water all the time (Habitat 1110), Reefs (1170) (Fig. 11), Submarine structures made by leaking gases (1180) and Submerged or partially submerged sea caves (8330). Moreover, three species included in Annex II of the HD such as the Bottle-nosed Dolphin, Common Porpoise and the Loggerhead Turtle were also included in the original proposal because they are generally found in this SAC. A total of 14 species of birds were also included in the original proposal, including the Audouin's Gull (*Ichthyaetus audouinii*), the Balearic Shearwater (*Puffinus mauretanicus*) and the Scopoli's Shearwater (*Calonectris diomedea*). This area has also been indicated as important for other cetaceans such as the Common Dolphin, the Stripped Dolphin, the Long-finned Pilot Whale and the Sperm Whale as well as for some invertebrates such as the Star Coral and the Knobbed Triton, classified as "Vulnerables" in the Catálogo Español de Especies Amenazadas (CEEAA) and Catálogo Andaluz de Especies Amenazadas (CAEA) or the Hatpin Urchin

(*Centrostephanus longispinus*) included in the Listado de Especies Silvestres en Régimen de Protección Especial (LESRPE) (Fig. 11) (Mateo-Ramírez et al. 2020c). The location and extension of habitats and associated biota of this SAC has not been detailed studied so far, but there is some knowledge on the populations of cetaceans (Notarbartolo Di Sciara et al. 2016). A recent study by Vázquez et al. (2015) listed different habitat types and associated communities of La Línea submarine canyon, including sea-pen and cerianthiid communities, gorgonians aggregations and cold-water coral banks (mainly of the White Coral *Madrepora oculata*, the Yellow Tree Coral *Dendrophyllia cornigera* and *Coenocyathus*) (Fig. 11).

The socio-economic importance of this SAC is mainly related to fisheries, aquaculture and tourism. Regarding fisheries, the artisanal fleet of mechanized dredging that targets bivalves (e.g. *Acanthocardia tuberculata*, *Chamelea gallina*) is of importance in the infralittoral bottoms, together with the artisanal fleet using trammel nets, purse seine and longlines. One of the most valuable species fished in the area (with its eastern limit in front of Gibraltar) is the Backspot Sea-bream which is caught by a locally designed hook line known as “voracera”. In circalittoral and bathyal zones, bottom trawling is the most common fisheries type and is performed by trawlers coming from harbours located close by (e.g. Algeciras, Estepona). Aquaculture practices have experienced a decline in the last decades, but mussel culture still occurs close to the La Atunara harbour. An increasing socio-economic activity in the area since the 80s is whale-watching, mainly for spotting different species of dolphins and small cetaceans.

The main threats of this SAC include the intense marine traffic across the Strait of Gibraltar (mainly for cetaceans and marine turtles), the bunkering (fuel delivery to anchored ships), marine pollution and eutrophication, coastal infrastructures and material deposition for beach regeneration, deployment of submarine cables and pipes,

bottom trawling and other types of fisheries that may be in contact with the seabed (e.g. bottom-set longline). Recently, the area has also been colonized by some invasive macroalgae, being the brown seaweed *R. okamurai* the one that is causing the greatest impact on the habitats and socio-economic activities of the area (e.g. artisanal fisheries) (Junta de Andalucía 2018).

5.4. Southern Waters of Gibraltar SAC (United Kingdom)

The Southern Waters of Gibraltar was approved as SCI in July 2006; however a protection regime has been in existence since 1991 through the Nature Protection Act. Following its approval as SCI, the Government of Gibraltar declared the Southern Waters of Gibraltar as a dual SAC (UKGIB0002) and SPA in March 2011. The MPA is located around the southernmost tip of Gibraltar, covering an area of 55 km² and a depth range from the coastline to ca. 800 m. This MPA overlaps with the Estrecho Oriental SAC proposed by the Spanish Government and the questions of sovereignty and jurisdiction over the waters around Gibraltar are still in debate between United Kingdom and Spain (Fig. 9). Moreover, the withdrawal of United Kingdom from the European Union (known as Brexit) in February 2020 may change the administrative status of this MPA because SACs are based on EU derived legislation to member states. Regarding its natural heritage, similar habitats and species occur in this MPA in comparison to the one of Estrecho Oriental SAC. This MPA was proposed because of the presence of two types of natural habitats included in Annex I of the HD: Reefs (Habitat 1170) and Submerged or partially submerged sea caves (Habitat 8330). Moreover, species included in Annex II such as the Bottlenose Dolphin (Fig. 9), the Loggerhead Turtle and 36 bird species were also included in the original proposal (Mateo-Ramírez et al. 2020c). The MPA is also located in an important migration route

for sea birds and several species stopover and feed during their migratory journeys, such as the Scopoli's Shearwater. Other species use the area during winter in variable numbers depending on weather conditions (e.g. high numbers of Northern Gannets feeding during storms). The Rock hosts several resident breeding pairs of European Shags (*Phalacrocorax aristotelis desmarestii*) (Fig. 8). Seasonal abundance due to migratory movements between the Mediterranean and the Atlantic, results in a multitude of pelagic and predatory fishes along with cetaceans including the Common and the Stripped dolphins which breed in the Bay of Algeciras (Ruiz et al. 2018). The rocky shores display important populations of the endangered Ribbed Mediterranean Limpet (Espinosa et al. 2005) (Mateo-Ramírez et al. 2020c).

The socio-economic importance of the Southern Waters of Gibraltar is related to tourism activities (two beaches namely Camp Bay and Little Bay), sport and recreational angling along with scuba diving and fisheries that are regulated through the Marine Protection Regulations of 2012 which build on the legislative provisions of the Nature Protection Act 1991. The main threats are somehow similar to those of the Estrecho Oriental SAC and include marine traffic, bunkering, marine pollution and eutrophication, coastal infrastructures and material deposition for beach regeneration and increasing the coastal area and invasive species such as the brown seaweed *R. okamurae* (Junta de Andalucía 2018).

5.5. Estuario del río Guadiaro SAC and Fondos Marinos Estuario del Río Guadiaro SAC (Spain)

The Estuario del río Guadiaro (Guadiaro River Estuary) was firstly designated Paraje Natural (Natural Area) in 1989. Posteriorly was proposed SCI (ES6120003) in December 1997, declared SCI in July 2006 and as SAC in November 2013. It is located

on the western part of the Guadiaro River, between the Málaga and Cádiz provinces (northern Alboran Sea). It covers an area of less than 1 km² of estuarine and terrestrial habitats, and a depth range from the coastline to ca. 4 m. It is connected with another SAC known as Fondos Marinos Estuario del Río Guadiaro (Marine bottoms of Guadiaro River Estuary) (ES6120034), which was proposed SCI in May 2007, declared SCI in December 2008 and SAC in August 2015. This last SAC covers an area of 1 km² of marine habitats with a depth range between the coastlines to ca. 20 m. The Guadiaro River estuary is framed by hillside deposits from nearby reliefs located both to the south-west and north-east where sandstone and shales formations of the Flysch Complex predominate, Lower Miocene in age (IGME 2012b). The most resistant layers of these units also outcrop on the outer continental shelf, near the Guadiaro submarine canyon, although the inner continental shelf is dominated by the deltaic deposits related to the Guadiaro river mouth.

The main estuarine-marine-related habitats represented in this 2 SACs are Estuaries (Habitat 1130 of the Annex I of the HD) and Sandbanks which are slightly covered by sea water all the time (1110). Nevertheless, the first SAC also contains a couple of terrestrial-riparian habitats that are interconnected with the estuarine system. The former SAC contains lush riparian vegetation associated with the Guadiaro River, which constitutes the habitat of some migratory birds. Despite the small size of this wetland, its strategic location on the north-eastern side of the Strait of Gibraltar favours the presence of birds such as the Purple Heron (*Ardea purpurea*), the Purple Gallinule (*Porphyrio porphyrio*) or the Common Little Bittern (*Ixobrychus minutus*). Other species are directly linked to the aquatic environment such as the Southern Straight-mouth Nase (*Pseudochondrostoma willkommii* an endemic river fish of the south-western Iberian peninsula), Great Sea Lamprey (*Petomyzon marinus*) (included in

Annex II of the HD) and the Eurasian Otter (Mateo-Ramírez et al. 2020c). The marine SAC represents an important area for the ecological connectivity function the Guadiaro River, being part of a fluvio-tidal system. The two SACs stand out as one of the few estuaries on the northern Alboran Sea, harbouring an ecosystem with an important ecological function, as a refuge, breeding and feeding area for various birds, invertebrates and fishes highlighting among them the Great Sea Lamprey.

The socio-economic importance of the two SACs is related to tourism activities (e.g. bird watching), sport (e.g. windsurf, kite surf, recreational fishing) and artisanal fisheries. The main threats include marine pollution and eutrophication, electric lines (bird collisions), development of human infrastructures (mainly pathways), illegal arid extraction and debris deposition, invasive terrestrial plant species (e.g. *Arundo donax*, *Cortaderia selloana*) as well as the brown algae *R. okamurae* (Junta de Andalucía 2018).

5.6. Fondos marinos de la bahía de Estepona SAC (Spain)

The Fondos marinos de la bahía de Estepona SAC (Estepona Bay marine bottoms) (ES6170036) (Fig. 12) was designed SCI in December 2000 with an extension of 5.5 km² but it increased to ca. 6 km² when it was declared SAC in August 2016. This SAC is located in front of Estepona between the harbour of Estepona and Punta de la Plata, separated ca. 150 m from the coastline and with a depth range from 1 to ca. 50 m. The Estepona Bay geology is dominated by the outcrop of the Estepona Flysch units dated from, Lower Miocene (IGME 1978a), and the submerged part by the development of sandy deposits associated with the littoral wedge.

This SAC was initially designated due to the presence of *Posidonia oceanica* beds (Habitat 1120 of the HD), which are associated with shallow rocky bottoms, at depths

not exceeding 4 m. These are distributed in two zones which occupy an area of 0.023 km² and a linear coverage of less than 30%. Other habitats such as Reefs (1170) and Submerged or partially submerged sea caves (8330) were detected once the SAC was declared. Reefs are represented by photophilic biocoenoses of the upper infralittoral rock in calm mode (1.5- 4m depth) and by circalittoral hard bottoms with coralligenous communities and some kelp. The most characteristic macroalgae varies with depth, including *Sargassum vulgare*, *Cystoseira usneoides*, *L. ochroleuca*, *P. purpurascens*, *Mesophyllum alternans*, *Lithophyllum stictaeforme*, *Lithophyllum incrustans* or *Peyssonnelia rubra*, among others. Regarding fauna, it is interesting to highlight the presence of species included in the Annex II and III of the HD such as the molluscs Saffiana Limpet and Knobbed Triton, the Broad Lobster (*Scyllarus arctus*), the Red Sea-squirt (*Halocynthia papillosa*), the bryozoan Ross Coral (*Pentapora fascialis*) or the fishes Seahorse (*Hippocampus hippocampus*) or Dusky Grouper. Other species occurring in this MPA are included in conservation or threatened lists (e.g. CAEA, Libro Rojo de los de Invertebrados de Andalucía) such as sponges (*Spongia* sp.) or gorgonians (Pink Sea Fan, *E. labiata*, *Leptogorgia sarmentosa*). Special relevance has the caves habitats because of the fragility and vulnerability their associated species, including invertebrates from Annex II of the HD such as the Hatpin Urchin or the Star Coral (Mateo-Ramírez et al. 2020c).

Tourism is one important socio-economic activity with a large number of hotels, beach bars, nautical channels and boathouses located nearby. The marina of Estepona has a large number of moorings (more than 400). Other economic activities are scuba-diving, nautical activities as well as recreational fisheries. The fishing port of Estepona has an important fishing activity, with a fleet of 75 boats, representing the second in importance in the Málaga province. The majority of these boats are dedicated to small-

scale gear (60 boats) as well as bottom trawling (7) and purse seining (6). The main target species are the European Sardine (*Sardina pilchardus*), Anchovy (*Engraulis encrasicolus*), Atlantic Bonito (*Sarda sarda*) and European Hake (*Merluccius merluccius*) as well as the Common Octopus (*Octopus vulgaris*). Regarding seafood fisheries, the target species in the SAC include bivalves such as the Banded Venus (*Polititapes rhomboides*), the Warty Venus (*Venus verrucosa*), Striped Venus Clam (*Chamelea gallina*), Wedge Clam (*Donax trunculus*), Smooth Clam (*Callista chione*) and Rough Cockle (*Acanthocardia tuberculata*) and the St. James' shell (*Pecten maximus*); gastropods such as the Trunk Murex (*Hexaplex trunculus*) and the Purple Dye Murex (*Bolinus brandaris*); the Sea Anemone *Anemonia sulcata* and echinoderms such as the Stony Sea Urchin (*Paracentrotus lividus*) and the Black Sea Urchin (*Arbacia lixula*).

The main threats are related with tourism, housing developments and maritime constructions that can cause burial and/or physical alteration of the seabed, modifications of environmental characteristics (increase in turbidity, modification of stream dynamics, erosion and sedimentation processes), marine pollution and eutrophication. In relation with scuba-diving, some impacts can be caused by the damage produced by physical contact, accumulation of bubbles, sediment resuspension, and collection of protected species or detachment of colonies of Star Coral from the substrate. Regarding fisheries, the main impacts are mechanical abrasion of the seabed, marine pollution and illegal collection of protected species. Different invasive species have also been detected in the SAC such as *A. taxiformis*, *C. cylindracea* and the brown seaweed *R. okamurae* (Junta de Andalucía 2018).

5.7. *El Saladillo-Punta de Baños SAC (Spain)*

The Saladillo-Punta de Baños SAC (Saladillo-Baños Point) (ES6170037) (Fig. 12) was proposed SCI in May 2007, designated SCI in February and designated SAC in August 2016. This SAC is located on the continental shelf, between Marbella and Estepona, covering an area of ca. 32 km² and a depth range between the coastline and ca. 50 m. It also includes the rocky known as “Placer de las Bóvedas” that rises from 60 m depth to 23 m depth located 5.6 km from the coast and situated close to the head of a submarine canyon. The coast is controlled by a series of coalescing alluvial fans from the nearby reliefs generated in different phases (IGME 1978b), with the seabed close to the coast characterized by hardened bottoms of various characteristics and rocky outcrops.

This SAC was firstly proposed by the presence of *P.oceanica* beds (Habitat 1120 of the HD) (Mateo-Ramírez et al. 2020b). The small *P. oceanica* patches develop on rocky outcrops between 3.5 - 6m depth covering an estimated area of ca. 0.01 km² (Fig. 12). Nevertheless, rocky reefs (Habitat 1170) were also included in this SAC after the inclusion of Placer de las Bóvedas inside the SAC. The rocky bottoms are represented by *Cystoseira* spp beds on rock and detritic bottoms as well as by pre-coralligenous and coralligenous communities in the area of Placer de las Bóvedas, occupying 3.03 km² (Fig. 12). The presence of rhodophytes such as *L. stictaeforme* and *Peyssonnelia* spp is highlighted, (Fig. 12) as well as species included in the Annex II of Berna and Barcelona convention such as the Star coral, the Knobbed Triton or the Hatpin Urchin. Other species included in conventions and threatened species lists, are the gorgonians *L. sarmentosa*, *Eunicella gazella*, *E. labiata*, the Pink Sea Fan and the Violescent Sea-whip, the Orange Tree Coral, the echinoderms *A. mediterraneus* and the Smooth Starfish (*Hacelia attenuata*), the bryozoan Ross Coral, the decapod crustaceans Spider Crab (*Maja squinado*) and the Spiny Lobster (*Palinurus elephas*) and fishes as the

Dusky grouper (Mateo-Ramírez et al. 2020c). Another interesting habitat occurring in the SAC is the rhodolith beds, which are especially abundant between 25-35m around Placer de las Bóvedas. These rhodolith beds are one of the very few occurring along the coasts of Málaga and are conformed by the coralligenous algae *Phymatolithon calcareum* and *Lithothamnion valens*.

The socio-economic importance of this SAC is mainly related to tourism, fisheries and aquatic activities such as scuba diving, sport fishing and recreational boats, all of them of importance in the area around Placer de las Bóvedas. Regarding tourism there is a high coastal development and urban services in the SAC and adjacent areas, including beach bars, hammocks, nautical channels and boathouses. The fishing fleet operating in this SAC is the same than in the Fondos marinos de la bahía de Estepona SAC. The main threats are punctual mechanical seabed abrasion (anchoring, artisanal fishery), bottom trawling in prohibited bottoms, marine pollution (Guadalmansa EDAR waste water treatment plant, long lines, plastic debris and litter), accidental capture of protected species, seabed alterations (increase in turbidity and sedimentation) due to beach restoration. At present, in addition to the occurrence of the algae *C. cylindracea* and *A. taxiformis*, the new recently arrived brown algae *R. okamurae* is increasing its populations (Junta de Andalucía 2018). This species has spread eastwards from the Strait of Gibraltar, producing impacts on fisheries and tourism because of the enormous quantity of seaweed wastes.

5.8. Calahonda SAC (Spain)

The coastline between Punta de Calaburras and Calahonda in the Málaga province was proposed SCI (Fig. 13) in January 2001, approved SCI in July 2006 and designated SAC in August 2015 (Calahonda, ES6170030). The SAC is located in the western part

of Málaga province along ca. 10 km of coastline between Fuengirola and Marbella, and covering an area of 14 km² and a depth range from the coastline to ca. 30 m. The coastal geomorphology and lithology display natural rocky outcrops in very few locations along the coast of Málaga province, being the area of Calahonda one of them. This area is characterized by rocky outcrops, abrasion surfaces and sandy deposits on the infralittoral wedge (Fig. 13). The main characteristics of this coastal sector are an active dune belt located to the west of the Cabopino harbour (also known as Artola harbour) and an alluvial fan system between the eolic system and the Palaeozoic rock outcrops that constitute the reliefs located to the north (IGME 1978c).

In the north-western sector of the Alboran basin, there are upwellings of cold deep and nutrient-rich waters due to hydrological and oceanographic features that promote an abundant phytoplankton production (García Raso et al. 2010). This high productivity and nutrient availability, together with the diversity of soft and hard bottoms, promote a great diversity of species which have led the Calahonda SAC to be recognized a biodiversity hotspot for the European waters (García Raso et al. 2010).

This MPA was proposed because of the presence of three types of habitats included in Annex I of the HD: Sandbanks which are slightly covered by sea water all the time (Habitat 1110), *Posidonia* beds (1120) and Reefs (1170) (Figure 13) (Mateo-Ramírez et al. 2020b). Moreover, two species included in Annex II of the HD such as the Bottlenosed Dolphin and the Loggerhead Turtle, and three species included in the Annex IV of the HD such as the Hatpin Urchin, the Ribbed Mediterranean Limpet and the Noble Pen shell (*Pinna nobilis*) were also included in the original proposal (Figure 13). The offshore area bordering Calahonda is of importance for other cetaceans such as the Common Dolphin, the Stripped Dolphin and the Long-finned Pilot Whale, all of them included in Annex IV of the HD. In addition, Fin Whales (*Balaenoptera physalus*) and

occasionally Orca, Pilot whales and Common Minke Whales (*Balaenoptera acutorostrata*) (also included in the Annex IV) spotted close to the SAC (Mateo-Ramírez et al. 2020c).

Other species with different protection status occur in the SAC, with the presence of emblematic species with a key role in the ecosystem, and therefore representing good ecosystem health indicators. This group of species includes the seagrass *C. nodosa*, included in the Annex I (strictly protected flora species) of the Bern Convention and in the Annex II (endangered or threatened species) of the BC; as well as two sponges (e.g. Common Antlers Sponge *Axinella polypoides*), nine molluscs (e.g. Knobbed Triton, Zoned Mitre *Episcomitra zonata*), five crustaceans (e.g. Spiny Lobster) and two echinoderms (e.g. Purple Sea Star) (Mateo-Ramírez et al. 2020c), all of them included in the Annex II and III of the BC, and some of them classified as “Vulnerable” or “in Risk of Extinction” in the CEEA and CAEA (Mateo-Ramírez et al. 2020c). The location and extension of some habitats and their associated biota of this SAC have been studied in detail by García Raso et al. (2010), with detailed works focused on dominant faunal groups such as molluscs (Urrea et al. 2011, 2013a, 2013b, 2017) and decapod crustaceans (García Muñoz et al. 2008; Mateo-Ramírez et al. 2012, 2016, 2018), including the description of some new species for the science as *Pagurus pseudosculptimanus*. (García Muñoz et al. 2014). A large proportion of tropical West African species is found in the SAC, with some of them reaching here their distributional limit towards the Mediterranean Sea, such as the bivalves *Ungulina cuneata* and *Modiolus lulat* (Figure 13). The rocky outcrop located at the western sector of the SAC (locally known as “Laja del Almirante”) harbours an interesting coralligenous community, which is considerably shallower than in other Mediterranean areas due to the high turbidity levels. This coralligenous community is conformed,

besides mobile groups (e.g. molluscs and decapods) by colonial organisms such as the gorgonians White Sea Fan, Pink Sea Fan, *E. labiata*, and *L. sarmentosa* as well as the bryozoans Ross Coral and *Myriapora truncata* (Figure 13), which are supported by the almost permanent highly nutrient upwellings occurring in the area. The presence of these bioconstructing species promotes a higher complexity that enhance the number of niches that can be potentially occupied by a large number of species, as found in Calahonda for decapod crustaceans (García Muñoz et al. 2008) and molluscs (Urrea et al. 2012).

The socio-economic importance of this SAC is mainly related to fisheries, both professional and recreational, and tourism. Regarding fisheries, small-scale gear fleets operating in the area include those using mechanical dredges targeting the Wedge Clam, the Striped Venus Clam, the Smooth Clam and the Rough Cockle, with the former three species being the most important ones in the regional market. Other artisanal fleets include those using minor gears, purse seine and traps. Main professional fishing harbours are located close by in Fuengirola and Marbella, whereas recreational ones are located in Cabopino (Marbella) and Fuengirola. The tourism sector is essential for the economy of the area. The strategic location within the Costa del Sol attracts many tourists because of its warm and sunny weather all year round, beaches and restaurants, with many small lodging establishments and hotels that offer overnight accommodation along the coastline of the SAC.

The main threats include the use of fishing gears that may cause seabed abrasion, especially when impacting the seagrass meadows, non-professional shell fishing such as the collection of intertidal sea anemones, holothurians, urchins and limpets, pollution by marine outfalls discharging local or industrial wastewaters and uncontrolled dumping, the alteration of the coastline by coastal infrastructures and material deposition for

beach regeneration, the extraction of aggregates from marine deposits and the presence of invasive species. The presence of the new invasive species *R. okamurae* should be highlighted, which was detected at a depth of 20 m in the Laja del Almirante in 2018 (Junta de Andalucía 2018).

5.9. Paraje Natural Desembocadura del río Guadalhorce (Spain)

The Paraje Natural Desembocadura del río Guadalhorce (Mouth of the River Guadalhorce Natural Area) is a coastal wetland included in the Inventory of Wetlands of Andalucía (code 617024) (Fig. 10) and listed as IBA by SEO/BirdLife (ES224). This site was proposed as Natural Area in July 1989, but before that the council of Málaga city declared it as a protected area in 1982 and prohibited housing developments. This MPA is located westwards of Málaga, covering an area of ca. 0.7 km². The original marsh at the mouth of the river was reduced by the construction of the Guadalhorce dam (1914-1921). Later on, although it was an agricultural area, the extraction of aggregates began in the 70s, forming the current lagoons which brought the water to the surface. Since then, it was protected after several discussions and agreements with the previous land owners. Nowadays, it is delimited by two channels of the Guadalhorce River, plus a third auxiliary one, forming an alluvial delta composed of detritic carbonated materials in which there are five small artificial lagoons of brackish and of fresh waters covering the gaps from the extraction of aggregates. The Guadalhorce river mouth is characterized by the development of a deltaic deposit inside an estuary that has progressively filled. The fluvial deposits and the littoral wedge are separated by a dune belt. In the submerged area, the fluvial flows and sediment loads form a submarine deltaic deposit off the Guadalhorce River, representing the main geomorphological feature. These deposits are generally composed of muddy sediments (Medialdea et al. 2014). Other submarine morphologies such as undulations field and creeping areas

developed on the submarine deltaic deposit, infralittoral wedge, scarp or abrasion surface areas occur off the coast of this MPA (Fernández-Salas et al. 2015). In adjacent areas to the deltaic system the sedimentary cover is composed by fine and coarse sands. The predominant littoral drift to the south-west produces a dynamic of active bars oblique to the coastline.

In the wetland area, different habitats included in the Annex I of the HD are present such as Coastal lagoons (Habitat 1150) or Mediterranean and thermo-Atlantic halonitrophilic thickets (*Sarcocornetea fruticosi*) (1420) (Mateo-Ramírez et al. 2020b). The salt marsh and riparian vegetation is diverse, including *Sarcocornia perennis*, *Scirpus maritimus*, *Juncus maritimus*, *Othanthus maritimus*, *Medicago marina*, *Ruppia maritima* and *Tamarix canariensis*, among others.

This MPA was designed because of its high ornithological diversity and its value as a stopover area for migratory birds. A large number of species included in the BD and lists of protections and conventions (Mateo-Ramírez et al. 2020c) use this MPA. Although it is located within the urban footprint of Málaga city, and despite its small size, it is unique for its extremely high diversity of birds, remarkable in the context of the Iberian Peninsula. The diversity and number of individuals seen rise dramatically during spring and autumn migrations, and also during winter, when numerous ducks (as Northern Shovelers *Anas clypeata*, Common Pochards *Aythya ferina* and Green-winged Teals *Anas carolinensis*), grebes (Little Grebe *Tachybaptus ruficollis* and Eared Grebe *Podiceps nigricollis*), egrets, herons, Greater Flamingos, Great Cormorants (*Phalacrocorax carbo*), gulls (e.g. Mediterranean, Black-headed, Lesser Black-backed and Slender-billed Gulls), sandpipers, plovers, raptors (mostly Ospreys, Booted Eagles *Hieraaetus pennatus* and Marsh Harriers *Circus aeruginosus*) (Mateo-Ramírez et al. 2020c), and a variety of passerines can be observed. It is particularly noteworthy the

presence of three Critically Endangered Species along the year, the Ferruginous Duck (*Aythya nyroca*), the Marbled Teal (*Marmaronetta angustirostris*), and the White-headed Duck (*Oxyura leucocephala*), which breeds in the lagoons. Along the coastal fringe it is possible to watch a variety of seabirds, such as the Scopoli's and Balearic Shearwaters, terns and gulls, during migration, and Northern Gannets and scoters during winter (Mateo-Ramírez et al. 2020c). The beach hosts a breeding population of Kentish Plovers. Other protected or endangered vertebrate species occurring on this MPA are the Eurasian Otter (Fig. 10) and the Mediterranean turtle *Mauremys leprosa*, among others (Mateo-Ramírez et al. 2020c).

The main socio-economic values are tourism and environmental education in a protected area located close to Málaga, the largest city in the Alboran Sea. The tourism and guided tours oriented to environmental education can enjoy a natural beach, trails and observatories for exploring the high diversity of birds, with up to 80 different species spotted within the same day, and 304 different species observed in the area. On the other hand, the protected area contains historical heritages, such as the Phoenician city of Cerro del Villar (S. IX B.C).

The main threat of this natural area is the pressure of Málaga city over this MPA (e.g. Málaga waster water treatment plant, etc.). Other important threats are the introduction of invasive species such as the Florida Turtle (*Trachemys scripta elegans*), which compete with some native species (e.g. *M. leprosa*) or the Monk Parakeet (*Myiopsitta monachus*). Another important factor is related to the high affluence of people to the beach during spring and summer months, that do not respect the delimited breeding zone in the MPA.

5.10. Acantilados y fondos marinos de la Punta de la Mona SAC (Spain)

The Acantilados y fondos marinos de la Punta de la Mona SAC (Cliffs and Marine bottoms of Punta de la Mona) (ES6140016) were proposed SIC in December 2003, approved in July 2006 and appointed SAC in August 2015. This SAC occupies an area of ca. 1.2 km² is located in the coast of Almuñécar (Granada), limiting to the east with the Peñón de las Caballas and to the west with the northern part of Las Terrazas development. It comprises small strips of coastal cliffs and a coastal strip, with a depth range from the coastline to ca. 60 m depth. Similar geological characteristics as the ones described in the Maro-Cerro Gordo Cliffs occur in this MPA (section 4.1 of this chapter).

Regarding habitats, its election as SCI was due to the presence of rocky bottoms (Reefs, Habitat 1170 of the HD), which in some areas reach 49 m depth, and harbour precoralligenous and coralligenous communities with a great richness of benthic species (Mateo-Ramírez et al. 2020b). Another habitat type is represented by submerged and semi-submerged caves (8330). Some threatened species, such as the Ribbed Mediterranean Limpet, the Star Coral, the Hatpin Urchin and the Common Antlers Sponge, inhabit these areas (Fig. 14). Populations of other species included in the Libro Rojo de los Invertebrados Andalucía, such as the gorgonian Violescent Sea-whip and the scleractinian Orange Tree Coral, are also present in this SAC (Fig. 14) Mateo-Ramírez et al. 2020c).

Snorkelling and scuba diving, apart from other touristic activities, are the main socio-economic activities, with several diving centres offering diving tours and with a large number of divers using Marina del Este beach as the point of origin for their dives. Small-scale gear fishing, with two boats that use the trammel nets, longlines and pots, targeting cephalopods and rockfish, operate in the SAC. Since 1980, this area has been subjected to a continuous series of anthropogenic disturbances. The main one was the

construction of the artificial beach of Marina del Este, in the inlet of Los Berengueles, and the recreational harbour of Marina del Este in the Roca de las Caballas, destroying areas with a high environmental value. These two constructions resulted on a massive housing development that still continues with the construction of new urbanizations. These cliffs hosted the last breeding pair of Ospreys in mainland Spain, which disappeared in 1982 due to the urban development pressures. Although Osprey has been recently reintroduced in western Andalusia, it can be observed only during migration. The increase of tourism led to an increase in wastewater discharges, boat anchoring, the number of sport fishers, illegal fishing and shellfish, etc (Fig. 14). Fishing, both artisanal and sport, has led to the disappearance of large serranids (e.g. large Dusky Grouper) and other large fishes, and it has had a great impact on benthic communities. The ropes of pots and longlines, the trammel nets, and fishing lines and hooks tear or split sponges and colonies of corals, gorgonians and bryozoans. The designation of this SAC should be supported by an effective management plan regulating all the activities that are causing current impacts.

5.11. Acantilados y Fondos Marinos Tesorillo-Salobreña SAC (Spain)

The Acantilados y Fondos Marinos Tesorillo-Salobreña SAC (Coastal cliffs and marine bottoms of Tesorillo-Salobreña) (ES6140013) were proposed as SCI in January 2001, approved in July 2006 and appointed as SAC in August 2015. This SAC occupies an area of ca. 10 km² and is located in the coasts of Almuñécar and Salobreña (Granada), limiting eastwards with El Pozuelo beach and westwards with Caleta de Salobreña. It comprises coastal cliffs reaching up to 15 m height from the sea and a marine strip with a depth range from the coastline to ca. 70 m depth. The cliffs located west of Salobreña correspond to graphite schists with quartzites and quartz-mica-schists with a medium to high metamorphic degree, although the town of Salobreña is located on an outcrop of

marbles, all of them are of Palaeozoic age belonging to units of the Alpujarride complex. To the west of Salobreña, the submerged marine area is characterized by muddy and sandy sediments on the infralittoral wedge; while to the east correspond to the deltaic plain and the submarine prodeltaic area of the Guadalfeo deltaic system.

Its election as SCI was due to the presence of *Zostera marina* meadows (Habitat 1110 of the HD), which unfortunately disappeared in 2009, and to the marine bird diversity with protected species such as Sanderlings (*Calidris alba*), the Little Egret (*Egretta garzetta*) or the Balearic Shearwater, as well as cetacean species as the Common or Bottle-nosed Dolphins among others (Mateo-Ramírez et al. 2020c). The reef habitat (Habitat 1170 from HD) is well represented in this SAC, with threatened species such the Ribbed Mediterranean Limpet, the Star Coral and numerous colonies of the gorgonian *L. sarmentosa* can be also highlighted (Fig. 15) (Mateo-Ramírez et al. 2020c). Since 2016, the presence of an incipient *C. nodosa* meadow has been observed in the bottoms previously occupied by *Z. marina* (Fig. 15).

Tourism is the main socio-economic activity, especially in Almuñécar, where beaches for swimming are more accessible by car. Recreational and artisanal fishing are both used in this area, being some of the target species Common Pandora (*Pagellus erythrinus*), Sea-bream (*Pagellus* spp.), Forkbeard (*Phycis phycis*), the Cuttlefish (*Sepia officinalis*), Striped Venus Clam and the Rough Cockle, among others.

There is also an installation of aquaculture cages in the north-eastern part that is currently obsolete. The illegal capture of invertebrates is one of the main threats, both the furtive shell fishing of molluscs and crustaceans, which occurs especially during the summer months, as well as the catch of the Sea Anemone. The great demand of this anemone in other Andalusian provinces has practically resulted in its disappearance in this area. In recent years, the illegal catch of holothurians for the Chinese market must

be also mentioned (Fig. 15). The different types of fishing, without specific restricting rules, have resulted in a decrease of fish populations. Particularly important is the pressure on the large serranids as the Dusky and Goldblotch Groupers. Poachers catch juveniles of these species that they sell to bars and restaurants. Although less frequently, some trawlers do not respect the limits of depth and/or distance, approaching a few meters from the coast. On some occasions the remains and debris of works carried out on the National 340 road and in housing developments are dumped on the cliffs, covering the vegetation and sometimes reaching the mesolittoral rocks.

5.12. Acantilados y Fondos Marinos de Calahonda-Castell de Ferro SAC (Spain)

The cliffs and marine bottoms located between the rocky coastlines of Gualchos and Motril were proposed as the Acantilados y fondos marinos de Calahonda-Castell de Ferro SIC (Cliffs and marine bottoms of Calahonda-Castell de Ferro) (ES6140014) in December 2003, approved SCI in July 2006 and designated SAC in August 2015. The SAC is located in the central part of the Granada coast and covers an area of ca. 9 km² with a depth range between the coastline and ca. 65 m. The coastal strip within the SAC is mainly configured by high cliffs and rocky formations with submerged and semi-submerged caves promoted by karst processes (Fig. 16). The cliffs are conformed by phyllites and quartzites, Lower to Middle Triassic age, and limestones or marbles of Middle to Upper Triassic age; however an unit of graphite schists with quartzites of medium metamorphic grade and Palaeozoic age emerges to the east of Cape Sacratif and Castell de Ferro (IGME 1981). There is only one pebble beach within the SAC known as “Rijana beach” with ca. 250 m length and located in a sheltered area. The Llanos de Carchuna has been characterized as a Holocene delta fan system. Massive rocky outcrops occur on the shelf, as well as unconsolidated sediments covering from

very fine sand to medium-coarse sand on the infralittoral wedge and continental shelf. Off Castell de Ferro, the Gualchos River has generated small prodeltaic deposits both to the west and east (Bárcenas et al. 2018).

The Atlantic anticyclone gyre promotes an upwelling of cold deep and nutrient-rich waters along the coasts of Málaga and Granada, which is enhanced by the westerly winds that usually blow in this area (Cebrián and Ballesteros 2004). This makes the area within the SAC to be subjected to a high productivity and nutrient availability, as detected in other MPAs located close. Furthermore, bottom currents and upwellings may favour the connectivity among deep and shallow soft bottoms, promoting the existence of bathyal species in circalittoral bottoms within the SAC (Marina et al. 2015).

This SAC was proposed because of the presence of nine types of natural habitats included in Annex I of the HD, of which five belong to the marine realm including Sandbanks which are slightly covered by sea water all the time (Habitat 1110), *Posidonia* beds (1120), Large shallow inlets and bays (1160), Reefs (1170) and Submerged or partially submerged sea caves (8330) (Fig. 16) (Mateo-Ramírez et al. 2020b). Moreover, two species included in Annex II of the HD such as the Bottle-nosed Dolphin and the Loggerhead Turtle, and at least five species included in the Annex IV such as the Ribbed Mediterranean Limpet, the Date Mussel (*Lithophaga lithophaga*), the Leatherback Marine turtles, the Common and Striped dolphins were also included in the original proposal (Mateo-Ramírez et al. 2020c). During migration it is easy to detect Audouin's Gulls and Balearic Shearwaters, while during the breeding period the most common seabird is the Yellow-legged Gull (*Larus michahellis*) (Fig. 16). The eastern area bordering Calahonda-Castell de Ferro is also of importance for the endemic Mediterranean seagrass *P. oceanica* (included in the Annex I of the Bern Convention

and in the Annex II of the BC), which presents extensive meadows down to ca. 10 m depth (Junta de Andalucía 2018). These beds provide a high ecological value, being the refuge and recruitment area for numerous species of commercial interest (Urrea et al. 2015).

In addition, several species with different protection status have been found in the area, such as the Knobbed Triton, the Noble Pen Shell (probably extinct since 2017) (Fig. 16), the Mediterranean reef-building vermetid gastropod (*D. lebeche*), the Star Coral and the Orange Puffball Sponge (*Tethya aurantium*) (Mateo-Ramírez et al. 2020c), all of them included in the Annex II of the BC, and some of them classified as “Vulnerable” in the CEEA and CAEA (Mateo-Ramírez et al. 2020c).

Sublittoral soft bottom assemblages within the SAC were detailed studied by Marina et al. (2015) in relation to sediment and water column variables. These authors documented the presence of some rare and poorly known invertebrates that are scarce in other areas of the Mediterranean Sea, such as the hippolytid decapod *Bythocaris cosmetops* and the tropical hermit crab *Pagurus mbizi* (García Raso et al. 2011, 2014) (Figure 16). Some bathyal molluscs (e.g. *Poromya granulata*, *Alvania testae*) display populations at shallower depths in the circalittoral zone of this MPA (Marina et al. 2015). The geographic location of the SAC, which represents a transitional and settlement zone for Atlantic species, the heterogeneity of soft bottoms and the occurrence of upwellings may favour the high biodiversity found in the studied soft bottoms.

The socio-economic importance of this SAC is mainly related to fisheries, both professional and recreational, aquaculture, agriculture and tourism. The activity of the artisanal fleet in the SAC is scarce, the remoteness of the closest port, located in Motril, influences this low activity. The main small gear used are gillnets for mullets (*Mullus*

sp.), *S. officinalis* and sparids as *Diplodus sargus*, *Pagellus erythrinus*, *Pagellus acarne*, etc. and pots (called “Alcatrúz” in the area) to catch Common Octopus. Recreational fishing from coasts and boats is usual in this SAC using surf-casting, trolling and jigging and targeting sparids, with the White Seabream (*D. sargus*) standing out. Aquaculture is an activity that is beginning to have some relevance on the coast of Motril, with one fishing farm located off Carchuna for the production of European Seabass (*Dicentrarchus labrax*) and Gilthead Seabream (*Sparus aurata*). The tourism sector is also very important in the area. The SAC stands out for its beautiful cliffs, which attract many visitors looking for activities related to scuba-diving, which is a deeply rooted activity in the seabeds of Calahonda-Castell de Ferro. The main threats include the use of fishing gears that may be in contact with the seabed, especially considering the seagrass meadows located close by; trampling over intertidal and upper infralittoral areas and illegal extraction of invertebrates such as the rock-boring Date Mussel, whose harvesting causes significant environmental damage; diving activities, which are very intense in summer and can affect populations of some species but also the overall community structure through physical injury or the removal of certain species. One of the most endangered invertebrates of the Mediterranean, the Ribbed Mediterranean Limpet, presents a population within the SAC and it is affected by recollection for human consumption, as bait for fishing, coastal developments, habitat modification and contamination.

5.13. Sur de Almería - Seco de los Olivos SCI (Spain)

The Sur de Almería- Seco de los Olivos SCI (Southern Almería - Seco de los Olivos) (ESZZ16003), was designated SCI in December 2014 and incorporated in the Natura 2000 Network in November 2015. This SCI will become a SAC after the development

of its corresponding management plan, including integrated measures to ensure the conservation of the habitats and species for which it was created.

The SCI is located in front of the Almería province, covering an area of ca. 2830 km² and a depth range from the coastline to ca. 1000 m depth. From the coast to the bathyal zone there is a great diversity of bottoms types, both rocky outcrops and sedimentary ones with different lithologies such as sands on the infralittoral of the continental shelf and muds on the continental slope, providing a wide diversity of habitats and marine organisms. Over the continental shelf a series of geomorphological features such as submarine escarpments, abrasion surfaces, sand wave fields and submarine fluvial deposit associated with the Adra River occur. Other geomorphological structures occur on the continental slope at greater depths such as submarine canyons (e.g. one section of the Almería canyon) and underwater elevations such as the promontory of Cabo de Gata and some banks such as Avenzoar - El Sabinar complex, Pollux and Chella, the latter also known as the Seco de los Olivos Seamount. This seamount is a volcanic outcrop included in the peri-Alboran Neogene volcanism. It is constituted by a central edifice, partially eroded, and covered by a sedimentary shelf wedge around it that generates a small isolated platform, and two NW-SE directed ridges located to the NE and SW respectively of the main edifice.

This SCI was proposed because of the presence of two habitats included in Annex I of the HD: *Posidonia oceanica* beds (Habitat 1120) and Reefs (1170); and two species of Annex II of the HD such as the Loggerhead Turtle and the Bottle-nosed Dolphin. Moreover, this SCI is also of importance for other occasional cetaceans, including the Cuvier's Beaked Whale, the Long-finned Pilot Whale and the Common Minke Whale, as well as for different birds including the Balearic Shearwater and the Audouin's Gull (Mateo-Ramírez et al. 2020c).

More than 600 species including fish and invertebrates have been listed so far in this SCI (de la Torriente et al. 2014). Many of these invertebrates are of importance because they appear in high densities and form three-dimensional structures that are home to other species, which settle, feed and take shelter in those habitats. In the coastal area, different seagrasses (mainly *P. oceanica* and *C. nodosa*) form extensive meadows (Habitats 1120 and 1110 of the HD). Rhodolith beds and coralligenous bottoms (Habitat 1170 of the HD) also appear in the coastal area, but mainly over the summit of some seafloor elevations, such as over the central “guyot” of the Seco de los Olivos Seamount (Mateo-Ramírez et al. 2020b). Further away a variety of habitats distributed in a patchy mosaic (some of them related to Habitat 1170) occur on Avenzoar Bank and the Seco de los Olivos seamount, including cold-water coral reefs (White Stony Coral *Desmophyllum pertusum* and White Coral), bamboo corals (*Isidella elongata*) and black corals (*Leiopathes glaberrima*, *Antipathes dichotoma*, *Antipathella subpinnata*) aggregations, glass sponges (*Asconema setubalense*, *Sympagella delauzei*) and demosponges (*Phakellia* spp., *Pachastrella monilifera*, *Thenaea muricata*) aggregations, giant oyster banks (*Neopycnodonte zibrowii*), large gorgonian gardens containing more than a dozen species (Pink Sea Fan, Violescent Sea-whip, *Swiftia dubia*, *Callogorgia verticillata*, *Viminella flagellum*, *Acanthogorgia hirsuta*, *Dendrobrachia bonsai*, among others), soft corals (*Alcyonium palmatum*, *Paralcyonium spinulosum*, *Nidalia studeri*) and Red Coral (*Corallium rubrum*) banks (Fig. 17) (Mateo-Ramírez et al. 2020c). A good representation of sedimentary habitats with habitat-forming species occurs in the SCI including, sea pen communities (*Funiculina quadrangularis*, *Kophobelemnon* spp., *Pennatula rubra*, *Pennatula phosphorea*, *Pteroeides griseum*, *Virgularia mirabilis*) and bamboo coral aggregations (Fig. 17).

The conservation of the cited habitats as well as many of their associated species depends on the development of appropriate management measures for the SCI. Considering just Seco de los Olivos Seamount, 45 species have been identified as protected and included in national and/or international conservation lists, including chordates (11 species), cnidarians (16 species), sponges (8 species), molluscs (5 species), crustaceans (2 species), echinoderms (1 species), tunicates (1 species) and bryozoans (1 species) (Mateo-Ramírez et al. 2020c).

The socio-economic importance of this SCI is mainly related to fisheries and tourism. In the area, fishermen use a great diversity of fishing techniques to catch different resources: purse-seine fishing for Atlantic Mackerel (*Scomber scomber*), European Sardine, Atlantic Horse Mackerel (*Trachurus trachurus*) and Round Sardinella (*Sardinella aurita*); bottom trawling for Atlantic Horse Mackerel, European Hake (*Merluccius merluccius*) and Blue and Red Shrimp (*Aristeus antennatus*); bottom long-line fishing for Blackspot Seabream; gillnet fishing for Scorpion Fish (*Scorpaena* spp.), mullets (*Mullus* spp.) and Cuttlefish; and fishing with traps or pots for Soldier Striped Shrimps. Moreover, recreational fishing has increased in the area, especially in specific seafloor elevations with steep rocky bottoms where species as the Dogtooth Grouper (*Epinephelus caninus*) occurs. Additionally, the area is highly frequented by tourists, including sport boat navigation and scuba diving in the coastal areas of Almería and more recently, activities associated with whale watching. The main threats facing the biodiversity of this SCI include some types of fishing such as bottom trawling, which generate incidental bycatch of sharks and cetaceans and the abrasion of the seabed and their benthic habitats; and marine traffic responsible for pollution caused by both the ship's bilge water releases and by plastics and waste disposal (Fig. 17).

5.14. Fondos Marinos de Punta Entinas-Sabinar SAC (Spain)

The Fondos Marinos de Punta Entinas-Sabinar SAC (Marine bottoms of Punta Entinas-Sabinar) (ES6110009) is located in the submerged platform in front of the Punta Entinas-Sabinar SAC (ES0000048), in the west of the Almería province (Fig. 18). This area was proposed SCI in 1997, approved in 2006 with ca. 20 km² and declared SAC in 2016 with an area of ca. 40 km².

The seabed of the SAC constitutes the submerged continuation of the great plain located at the foot of the Gádor mountains range between the housing developments of Roquetas de Mar and Almerimar (El Ejido harbour) characterized by sandstones and silts of Messinian - Lower Pliocene age. All this coast is low and is part of the Punta Entinas-Sabinar SAC and contains some coastal lagoons, wet areas and old salt marshes that are no longer used (Pérez Hurtado de Mendoza 2004), as well as a strip of Holocene dunes with Phoenician Junipers *Juniperus phoenicea* subsp. *turbinata* and Mastic Trees *Pistacia lentiscus* (López-Martos et al. 2010).

The SAC occurs on the infralittoral wedge and is mainly characterized by fine sands, small areas with gravels and rhodolith beds together with some flattened rocks associated with rocky outcrops, on which *P. oceanica* also develops (Moreno and Guirado 2003; Moreno et al. 2004a; Arroyo et al. 2015) (Fig. 18). The main habitats of this SAC are the seagrass meadows of *P. oceanica* (Habitat 1120 of the HD); the Sandbanks which are slightly covered by sea water all the time (1110) in which *C. nodosa* frequently forms meadows (Moreno et al. 2004b) and the Reefs (1170), in some areas of flattened rocks with macroalgae meadows of the *Cystoseira* spp. between 10 and 20 m depth (Fig. 18). The cartography of seagrass meadows was firstly carried out using scuba-diving in 1995-1996 (Luque et al. 2004) and later on updated with side scan sonar during the Life+ *Posidonia* Andalucía Project (2011-2016) (Mendoza et al. 2014;

Arroyo et al. 2015). In 2008, OCEANA conducted a restoration experience of *C. nodosa* meadows by collecting seeds in front of Punta Elena (next to the Cerrillos tower) and planting them in Roquetas de Mar and Punta Elena (García et al. 2009).

In this SAC, a *P. oceanica* sampling station with demographic grids has been monitored every year within the POSIMED Network under the framework of the Life+ *Posidonia* Andalucía Project (Junta de Andalucía 2017, 2018). During this project, censuses of fish, macroalgae, epiphytes and macro invertebrates were carried out for studying the biodiversity of those meadows (Junta de Andalucía 2012, 2013).

Some threatened invertebrate species such as the Hatpin Urchin and the Knobbed Triton (Vulnerable) occur in this SAC (Junta de Andalucía 2018) (Mateo-Ramírez et al. 2020c). The Noble Pen Shell was scarce in the seagrass meadows, and no individuals could be detected in 2016 after a massive mortality event that has affected 100% of the population of the northern Alboran Sea (Junta de Andalucía 2017; Vázquez-Luis 2017).

The entire west coastline of the Almería province, except just the narrow strip of the adjacent SAC, is very urbanized and intensively used for agriculture appearing from satellites covered by plastic greenhouses (campo de Dalías-El Ejido and Roquetas de Mar). Therefore, this SAC could be affected by spills from nearby urban and agricultural areas, as well as waste of all kinds, mainly of plastics. This coast is very open and receives storms coming from the east as well as from the west, so it could receive potential contamination from maritime traffic accidents such as oil spills. In addition, overfishing, including recreational fisheries, can affect the ichthyofauna that is already very scarce in the SAC.

5.15. Arrecife barrera de Posidonia Natural Monument and Arrecifes de Roquetas de Mar SAC (Spain)

The area known as “Los Bajos de Roquetas”, located between Roquetas de Mar and Aguadulce in the western part of the bay of Almería, has a low and sandy coast and predominantly soft bottoms on which extensive seagrass meadows develop on the infralittoral wedge. One of the most notable formations is the barrier reef of *P. oceanica* (Fig. 19), which is next to the wetland area called Ribera de la Algaida and the Turaniana site, where there was a small Roman port (Cara Barrionuevo 1994). This remarkable reef of *P. oceanica* is the largest and most complete in the northern Alboran Sea. It was declared in 2001 as a Natural Monument (Monumento Natural) of biotic character, with the name of Arrecife barrera de *Posidonia* (Barrier Reef of *Posidonia*) and covering an area of ca. 1.1 km² (Guirado et al. 2002; Castro et al. 2003). The declaration of this Natural Monument was done by the Andalusian Government and included basic management criteria and a list of unsupported activities, such as anchoring and trawling, among others. This MPA is 2 km long and 550 m wide (50m stretch along the beach) and a depth range between the coastline to ca. 10-12 m. Subsequently, this MPA was approved as SCI in 2006 with the name Arrecifes de Roquetas de Mar (Roquetas de Mar Reefs) (ES6110019), occupying an area of ca. 2 km², and finally designated SAC in 2016.

The main value of this SAC is *P. oceanica* meadows (Habitat 1120 of the HD) that conforms an extraordinary barrier reef, where seagrasses reach the surface. The structure of the *Posidonia* reef is similar to that of tropical hermatypic (or reef-building) corals that conform a separate coastline ridge where waves break and an inland lagoon with muddy sediments colonized by other marine angiosperms such as *C. nodosa* and *Z. noltei* (Habitat 1110 of the HD) (Moreno 2003; Luque and Templado 2004; Arroyo et

al. 2015) (Fig. 19). It should be highlighted that the four species of native marine angiosperms of European waters (*P. oceanica*, *C. nodosa*, *Z. noltei* and *Z. marina*) occurred in the SAC at the end of the 20th century, before the acute regression of *Z. marina* in the northern Alboran Sea during 2006-2007 (Moreno and Guirado 2003). The cartography of these seagrass meadows was firstly carried out using scuba-diving in 1995-1996 (Luque et al. 2004), and later on updated with side scan sonar during the Life+ *Posidonia* Andalucía Project (2011-2016) (Mendoza et al. 2014; Arroyo et al. 2015). Demographic grids and biodiversity census were carried out in this SAC from 2011 to 2018 during the latter project (Junta de Andalucía 2012, 2013, 2017, 2018).

In the *P. oceanica* meadows, the concretions of the coralline algae *Mesophyllum alternans* algae are frequent, which are home to a rich and diverse fauna with abundant polychaetes, crustaceans and small molluscs (Salas and Hergueta 1986; Hergueta and Salas 1987). The macrofauna of the seagrass meadows is known from different studies (Ballesteros et al. 1986), including the results of cartography campaigns (Luque and Templado 2004). It is important to note that the waves bring a large amount of debris from the nearby *P. oceanica* (leaves, rhizomes) to the shore that accumulate on the beach and support an interesting detritivorous fauna adapted to this habitat, with different species of amphipods, isopods and polychaetes, among others (Luque and Templado 2004).

Different species of echinoderms, mainly of the genus *Holothuria*, and the sea urchin *Paracentrotus lividus* (Annex II of the BC) (Fig. 19) (Mateo-Ramírez et al. 2020c), are very abundant in the SAC, which could contribute to seagrass degradation because that sea urchin feed on *P. oceanica* (Junta de Andalucía 2012, 2013). The endangered Noble Pen Shell was scarce in these meadows, but it no longer lives there because of the

aforementioned massive mortality event in 2016 (Junta de Andalucía 2017; Vázquez-Luis 2017).

The main socio-economic activities are related with tourism, scuba-diving (prohibited inside the Natural Monument) and fisheries. In the fishing port of Roquetas de Mar the main gears used are small-gear fishing, e.g. trammel (10 boats). Nevertheless, other boats use other gears such as long-line (4), shellfish dredges and purse-seine fishing (3). The main target species of those fisheries are Common Octopus and Cuttlefish. In addition the port of Roquetas has 183 moorings for recreational boats, with some of them fishing in the MPA. Different human pressures, such as mass tourism and urban discharges as well as marks of dredges and illegal trawlers have been mentioned for this MPA (Arroyo et al. 2015). The latter affected the *Posidonia* meadows outside 12-14 m depth at the end of the 20th century which caused meadow degradation with a large area of “dead matte”. In addition, the green algae *C. cylindracea* was detected for the first time at a depth of 14 m on “dead matte” in 2014, which may represent a very suitable bottom for the development of this exotic invader (Junta de Andalucía 2014).

5.16. Isla de San Andrés Natural Monument and SAC (Spain)

The island of Carboneras (also known as Isla de San Andrés) is located at the northeastern limit of the Alboran Sea, in front of Carboneras (Almería) (Fig. 20). It was declared a Natural Monument of mixed nature (geological and biotic), with the name of “Isla de San Andrés”, in 2003 by the Andalusian Government (Castro et al. 2003). The protected area covered ca. 0.7 km² and included both the emerged part of the island and the infralittoral bottoms around it. In 2006, the area was approved as SCI with the name Islote de San Andrés (San Andrés islet) (ES6110020), covering a larger area (0.35 km²) and including both the island and one small islet located close to the beach. In 2015, it

was declared SAC, covering the same area of 0.35 km². The 180 m long island is quite flattened and reaches a height of only 14 m above sea level, but in the submerged part reaches 40-50 m depth relatively close to the shore. The island is constituted of volcanic materials, mainly dacites and andesites from the Calcoalkaline series of the Neogene volcanic peri-Alboran Sea domain. These materials are covered by Quaternary age alluvial deposits made up of conglomerates with a great diversity of boulders. The seabeds are rocky corresponding to the volcanic materials and are characterized by the presence of cornices, cracks and caves.

The main biological values are found in the submerged part where a very steep rocky substrate dominates, with walls and passages, which harbour extraordinary dives for dive centres. In the mesolittoral, there are some formations of the vermetid *D. lebeche*. In addition there are excellent *P. oceanica* meadows (Habitat 1120 of the HD), partly on rock, as well as sand bottoms with *C. nodosa* meadows (1110). In those *P. oceanica* meadows, there was an annual monitoring station of the endangered Noble Pen Shell until its massive mortality and extinction in 2016 (Junta de Andalucía 2016; Vázquez-Luis et al. 2017).

In 2008, the Sustainable Management Program of the Marine Environment of the Andalusian Government carried out the bionomic mapping of this SAC and its adjacent areas, covering 0.75 km² in total, of which 0.08 km² corresponded to *P. oceanica* meadows (Junta de Andalucía 2008). There are also an interesting coralligenous bottoms (Habitat 1170 of the HD) with gorgonians, mainly *L. sarmentosa* (included Libro Rojo de los Invertebrados de Andalucía) as well as caves and rocky passageways with solitary corals such as *Leptopsammia pruvoti* (Figure 20) (Mateo-Ramírez et al. 2020c).

In this MPA, a *P. oceanica* sampling station with demographic grids has been monitored every year within the POSIMED Network under the framework the Life+ *Posidonia* Andalucía Project (Junta de Andalucía 2017, 2018). Within the same project, demographic grids and biodiversity census were carried out in this SAC from 2011 to 2018 (Junta de Andalucía 2012, 2013, 2017, 2018). This MPA displayed the highest species richness for fish (21 species) and macro invertebrates (19 species) after comparisons with other sampling stations of the northern Alboran Sea (from Almería, Granada and Málaga) (Junta of Andalusia 2012, 2013) (Mateo-Ramírez et al. 2020c).

The socio-economic importance is related to fisheries and tourism. The port of Carboneras has the highest influence within the MPA, being the main fishing gear surface longline and small-gear fishing. Tourism activities are related with the recreational fishing and scuba diving / snorkelling. The main threat to this MPA is the increase of diving activities because 4 dive centres from Carboneras perform dives continuously in fragile environments such as small caves. During the Life+ *Posidonia* Project, the Junta de Andalucía installed 4 ecological buoys around the island to avoid anchoring in the seagrass meadows (Mendoza et al. 2014). In addition, this MPA is located in the area of influence of two underwater emissaries of urban activity located in front of Playa del Lacón.

6. Other Marine Protected Areas and Key Biodiversity Areas from the southern Alboran Sea and adjacent areas

Different MPAs and KBAs located in the southern Alboran Sea and adjacent areas are presented from west to east direction, with remarks on their location, figure status, natural heritage, socio-economic importance and main threats.

6.1. Jbel Moussa Nature Reserve, Site d'Intérêt Biologique et Ecologique (SIBE) and Réserve de Chasse Permanente (RCP)

Jbel Moussa was designated a Biological and Ecological Interest Site (Site d'Intérêt Biologique et Ecologique) with priority 1 because of its interest and uniqueness. It is also part of the Intercontinental Biosphere Reserve of the Mediterranean, declared by UNESCO in 2006, which covers various protected natural areas in Andalusia and Morocco. Moreover, it has also been recognized as an Important Bird and Biodiversity Area (IBA) and in 2014 was proposed as Nature Reserve. This MPA occupy a total area of 48 km² from which ca. 11 km² are marine with depths range from coastal lines to more than 400 m depth.

This is the northernmost protected natural area of Morocco and its boundaries include the rural communes of Taghremt and Ksar Majaz, as well as the village of Belyounech.

This karstic limestone massif, rising more than 800 m above sea level, is constituted by units from the internal Rif domains, represented by the Séptides, Gomárides and the Dorsal units, where Jbel Moussa himself is made up of the latter, and also by the domain of the Flysch Complex, formed the Tariquides and Mauritanides units. Limestones and dolomites of the Upper Triassic-Lower Liasic dominate in the area. The coastal section is characterised by capes, steep cliffs, coastal abrasion platforms, small beaches and two rocky islets, one of them consisting of limestones (known as Perejil) and the other forms by sandstones (known as El Guardian).

The maritime area of this MPA is represented by several habitats that are similar to the ones listed in Annex I of the HD can be identified in the area such as Reefs (Habitat 1170), Sandbanks which are slightly covered by sea water all the time (1110), Mudflats and sandflats not covered by seawater at low tide (1140) or Submerged or semi-submerged marine caves (8330). Vegetated bottoms are predominantly located at the

northern area of the MPA, with rocky outcrops dominated by stratified algal communities that are organized from green to brown and red algae following a depth gradient down to ca. 25 m (Kazzaz 1989). Seagrass meadows are also found on soft bottoms of the MPA (1110 and 1140), mainly composed of *Zostera noltei* and *Cymodocea nodosa* (Mateo-Ramírez et al. 2020b). Furthermore, the islet of Perejil (island of Leila in Moroccan) is located 200 m off the coast, and it represents a refuge for many species due to its isolation and the difficulty of access. This islet harbours interesting underwater seawalls, caves and coral formations.

Regarding birds, this MPA represents an important migration hot spot for the pass of migrating seabirds between the Atlantic Ocean and the Mediterranean Sea, with a large number of species of seagulls (*Ichthyaetus* spp.) with a nesting colony of Caspian Gull (*I. cachinnans*), in Perejil islet, different terns (*Sterna* spp.), shearwaters, including the highly threatened Balearic Shearwater (*Puffinus mauretanicus*), cormorants (*Phalacrocorax* spp.), small plovers (*Charadrius* spp.) and knots (*Calidris* spp.) that can be observed in the area and around (Mateo-Ramírez et al. 2020c).

Marine mammals are commonly observed, as they cross the Strait of Gibraltar in their migratory routes. Common species include the Bottle-nosed Dolphin (*Tursiops truncatus*), the Common Dolphin (*Delphinus delphis*), the Striped Dolphin (*Stenella coeruleoalba*), the Common Porpoise (*Phocaena phocaena*), the Orca (*Orcinus orca*), the Long-finned Pilot Whale (*Globicephala melas*), the Sperm Whale (*Physeter macrocephalus*) and the Fin Whale (*Balaenoptera physalus*) (Mateo-Ramírez et al. 2020c). Other threatened and/or endangered species include marine turtles (e.g. Loggerhead *Caretta caretta*, Leatherback *Dermochelys coriacea*), fishes such as the Bluefin Tuna (*Thunnus thynnus*), the Dusky Grouper (*Epinephelus marginatus*)

including sharks such as the Sweet William (*Mustelus mustelus*), Common Hammerhead Shark (*Sphyrna zygaena*), among others (Mateo-Ramírez et al. 2020c).

The seawater quality provides the optimal conditions for threatened/endangered and vulnerable invertebrate species such as the Red Coral (*Corallium rubrum*) and the crustaceans Slipper Lobster (*Scillarides latus*) or Spider Crab (*Maja squinado*) (Mateo-Ramírez et al. 2020c).

The main socio-economic activities are tourism and fishing. The surrounding cities and towns have an important urban and tourist-residential component. The whole area has an important potential for outdoor activities such as hiking, trekking, ornithological or scientific tourism, environmental education, diving and sport fishing, apart from the traditional sun and beach tourism (VVAA 2013). The presence of large numbers of whales fed a highly lucrative Whaling industry at both sides of the Strait, and the remains of the old whaling stations can be found at Belyounech (Morocco) and Algeciras (Spain). A permanent and locally important artisanal fishing activity, with trammel nets, purse seine from coast, longlines and jigging can be found in this MPA, targeting species such as the European Sardine (*Sardina pilchardus*), European Sea Bass (*Dicentrarchus labrax*), European Conger (Conger conger), Axillary Seabream (*Pagellus acarne*), Common Octopus (*Octopus vulgaris*), Mediterranean Mussel (*Mytilus galloprovincialis*) or the Pink Spiny Lobster (*Palinurus mauritanicus*) (VVAA 2013).

The main threats of the area are trawling and overfishing, as well as a potential large-scale industrial and maritime trade development. In addition, the lack of regulation of some traditional activities, such as fisheries, lack of adequate infrastructures for fishing, poor waste and wastewater management, together with low sensitivity to waste dumping and its visual impact, poaching, and lack of a Management Plan for the MPA

are also important weakness (VVAA 2013). Further studies and analyses on the different uses of the area and their possible impacts on biological communities and ecosystems are needed.

6.2. Zona marítimo-terrestre del Monte Hacho (SAC (Spain))

The Zona marítimo-terrestre del Monte Hacho SAC (Maritime-terrestrial zone of Monte Hacho) (ES6310002) was proposed SCI in April 1999 and declared SAC in July 2012. This SAC occupies ca. 9 km² of which 96% are of marine character, with a depth range from the coastline down to 200 m depth. The coastline of Monte Hacho presents an irregular and rugged relief where cliffs are the predominant structures with lesser extent areas of medium-thick material deposits, with similar characteristics for the sublittoral areas. The Monte Hacho massif is constituted by metabasites and amphibolites with local outcrops of peridotites and leucogranite that corresponds to the mafic formations present in the Septide Complex (IGME 2013).

In this SAC some habitats included in Annex I of the HD are Reefs (Habitat 1170), followed by Submerged or semi-submerged marine caves (8330) and Vegetated sea cliffs of the Atlantic and Baltic Coasts (1230) (Mateo-Ramírez et al. 2020b). Associated with the reefs a wide diversity of communities has been detected, including different gastropods included in conservation lists (e.g. the Ribbed Mediterranean Limpet *Patella ferruginea*, the vermetid *Dendropoma lebeche*) as well as coralline algae (*Lithophyllum byssoides*) at the intertidal level, photophilous macroalgae beds (*Cystoseira* spp.) as well as pre- and coralligenous communities with the Filigreed Coral-worm (*Filograna implexa*) or the Star Coral (*Astroides calycularis*) in the shallow infralittoral level and some gorgonians and Red Coral aggregations with the Whip Gorgonian (*Ellisella paraplexauroides*, Annex II from BC), *Phyllangia mouchezii* (Barea-Azcón et al. 2008)

or the endangered Red Coral at larger depths (Mateo-Ramírez et al. 2020c). Sand and detritic bottoms are also abundant at the circalittoral level with high abundances of pennatulaceans dominated by *Veretillum cynomorium*.

This SAC is an important area for migratory seabirds, especially for the Cory's Shearwater (*Calonectris diomedea*), because every autumn more than half a million of individuals leave the Alboran Sea and pass very close to the coast. Other species are the Audouin's Gull (*Ichthyaetus audouinii*), recently established as a breeding species in Ceuta, and the Sandwich Tern (*Thalasseus sandvicensis*) during winter and migration. The cliffs and abrupt walls are used by cliff nesting species such as the Peregrine Falcon (*Falco peregrines*), the Kestrel (*Falco tinnunculus*), the Crag Martin (*Ptyonoprogne rupestris*) and Blue Rock Thrush (*Monticola solitarius*) for nesting and wintering (Mateo-Ramírez et al. 2020c).

Regarding socio-economic activities, some of them are recreational marine fishing, in its different modalities, from the shore or using boats and snorkel equipment. Scuba diving is an activity that has been on the rise in recent years with several Dive centres operating from Ceuta. There are also two beaches (Santa Catalina and El Desnarigado) with a low affluence. In contrast, the main threats are related to the presence of the invasive macroalgae *Rugulopteryx okamurae* which was detected in Ceuta during 2015 and which has suffered a huge expansion in the last years (Rosas-Guerrero et al. 2018), competing over other invasive species such as *Asparagopsis armata* and *Caulerpa cylindracea* (MTERD 2020) and affecting both photophilic/sciaphilic algae to pre- and coralligenous habitats. Other threats are the presence of a submarine emissary in the northern area of the SAC, development of transport systems (roads), construction of residential or recreational areas, modifications of the coastline, reductions of fish

populations and physical damage of marine habitats by fisheries and recreational activities such as scuba diving.

6.3. Lagune de Smir SIBE and collateral figures of protection (Morocco)

The Smir lagoon is one of the coastal wetlands with the highest natural value for the Mediterranean Moroccan coasts. In 1995, it was declared a SIBE by the High Commission for Water & Forests for combating desertification. In 2006, this wetland was included in the Intercontinental Mediterranean Biosphere Reserve Andalusia-Morocco (Reserva Intercontinental de la Biosfera de Andalucía-Marruecos), of the UNESCO MaB programme, and as a Ramsar site in 2019.

The Smir lagoon is located on the coastal plain of the Smir River north of the city of M'diq. It is flanked to the north by the Jebel Zem-Zem mountain range, to the south by the Koudiet-Taifo mountain range, and to the west by limestone and dolomitic ridges. The MPA has an extension of 2.46 km² occupied by a permanent lagoon and some marshes, located in the lowest area of the valley. This lagoon has a maximum depth of 2.5 m and it is mainly fed by the sea because it is connected by a permanent channel that passes under a bridge on the national road that leads to the Port of Kabila. This ecosystem, which functioned before as a lake, has been transformed into a coastal lagoon. The lake had an area of about 2 km², but its functioning was affected by the construction of a water dam on the Smir River and the construction of a port at its mouth, which have modified the hydrological system and induced a progressive salinization of the waters. This increase in salinity has affected the composition, structure and functioning of the biological communities, benefiting halophytic plant communities and the intrusion of marine species with the total disappearance of freshwater species.

This SIBE is represented by coastal and halophytic vegetation habitats, similar to the ones listed by the European HD such as Estuaries (Habitat 1130) and *Salicornia* and other annuals colonizing mud and sand (1310), as well as by Sandbanks which are slightly covered by sea water all the time (1110) (Dakki et al. 2005) (Mateo-Ramírez et al. 2020b). Different habitats conformed by aquatic angiosperms occur in the lagoon. At the mouth of the Smir River, where a confluence of fresh and sea water occurs, vegetated habitats dominated by *Potamogeton pectinatus* and *Z. noltei* occur. Whereas, the southern sector near the channel is dominated by *R. maritima* and *C. nodosa*. Finally, the communities closer to the sea are dominated by macroalgae (Benhissoune et al. 2005).

The Smir lagoon is a stopover area for the birds that cross the Strait of Gibraltar and the high variety of biotopes and the heterogeneity of its plant formations promotes a high ornithological richness. Most of the birds are similar to the ones listed on the Annexes of the European BD with migratory species such as shorebirds, herons, the Glossy Ibis (*Plegadis falcinellus*), raptors as the Osprey (*Pandion haliaetus*) or the Marsh Harrier (*Circus aeruginosus*), and passerines (Mateo-Ramírez et al. 2020c). Other birds are subject of special conservation measures, such as the Pied Avocet (*Recurvirostra avosetta*), the Purple Heron (*Ardea purpurea*) or the Black-headed Gull (*Chroicocephalus ridibundus*). Furthermore, every year thousands of birds winter in this lagoon, mainly anatidae such as the Northern Pintail (*Anas acuta*), the Northern Shoveler (*Anas clypeata*) or the Common Pochard Tufted Duck (*Aythya ferina*). It is remarkable the presence and reproduction of the Red-knobbed Coot (*Fulica cristata*) (Castro et al. 2006) (Mateo-Ramírez et al. 2020c).

In the Smir lagoon, an important diversity of other vertebrates occurs, with similar fishes as included in Annexes of the HD like the Greater Pipefish (*Syngnathus acus*),

the Seahorse (*Hippocampus hippocampus*) together with gobies or mammals such as the Eurasian Otter (*Lutra lutra*) (<https://rsis.ramsar.org/ris/2380>). The benthic macrophytes of this lagoon host a diverse community of benthic invertebrates with amphipods, isopods, polychaetes, bivalves and gastropods as dominant groups (Chaouti and Bayed 2005).

Tourism is the most important socio-economic activity for the city of M'diq and the surrounding urban areas. Agro-pastoral activities are also a source of income, mainly from cereal crops and the production of local cattle. Currently, the MPA is under high urban pressure, related to population growth throughout the coastal area. Tourism pressure and summer residences are causing the expansion of the city of M'diq, which threatens the lagoon to the south and east. Despite being a SIBE and a Biosphere Reserve, no agency has intervened to stop the advance of the developments that are proliferating around the lagoon, which may seriously affect its vegetation. The destruction of the habitat and the discharge of wastewater into the lagoon are seriously affecting the life cycle of the birds. Birds are also greatly affected by human pressure, mainly from illegal hunting.

6.4. Koudiet Taifour SIBE and Réserve de Chasse Permanente (Morocco)

Koudiet Taifour was declared as SIBE in 1995 by the High Commission for Water & Forests and combating desertification, and it was included in the third level of priority for conservation. The reason it was listed as SIBE was the presence of species and habitats of conservation interest for the Mediterranean, ecological, biological and aesthetic integrity of the site involved, as well as the socio-economic importance of the area (fishing, recreational and tourism activities). Additionally, Koudiet Taifour was

designated a Permanent Hunting Reserve (Réserve de Chasse Permanente, RCP) in 2012.

The RCP occupies an area ca. 11 km², whereas the MPA covers an area of 5.32 km² but only 0.65 km² correspond to marine area which goes down to 30m depth from the costal line. It is bounded to the north by Cabo Negro and the city of M'diq, and to the south by the Martin River that runs between Matril and Tetouan. Koudiet Taifour is a highly urbanized area with ports and tourist accommodations, which has led to the loss of its character and its high-quality landscape.

In this MPA different types of habitats have been listed, with some of them representing similarities with the ones listed in Annex I of the HD. In the terrestrial part, dunes with *Pinus pinea* (similar to Habitat 2270 of HD) are present. Strictly marine habitat are Sandbanks which are slightly covered by sea water all the time (1110) with seagrass meadows conformed by *C. nodosa*. The second main habitat is Reef (1170) (Mateo-Ramírez et al. 2020b), with mesolittoral communities and associated species such as the Saffian Limpet (*Cymbula safiana*), the Ribbed Mediterranean Limpet (and vermetid reefs of *D. lebeche*, and with coralligenous communities formed by red algae *L. byssoides*, the Star Coral and other molluscs species such as the Rough Pen Shell (*Pinna rudis*) on infralittoral bottoms (MedMPAnet 2012). All these species are included in the Annex I (strictly protected species) of the Bern Convention and/ or in the Annex II (endangered or threatened species) of the BC (Mateo-Ramírez et al. 2020c).

Although, the fishing activity in the area is carried out on a small scale by artisanal fishing boats docked in the port of M'diq, the tourism is the main socio-economic activity in this coast (Jiménez and Almonacid 2008). In spite of being a SIBE, the coast of Koudiet Taifour has suffered a landscape and functional transformation in the last decades, caused essentially by the boom in the construction of urbanizations for

tourism. This expansive strategy of tourism infrastructure, which has had a great impact on the environment, threatens to continue in the future due to its high economic importance.

6.5. Côte Rhomara SIBE and RCP (Morocco)

Côte Rhomara was proposed as SIBE under the framework of the Protected Areas Master Plan of Morocco of 1996 (AEFCS 1996) because of its aesthetic value, scientific and educational interest. Its declaration as SIBE was done because of certain artisanal fishing practices in this sector of the Mediterranean Moroccan coasts but also in relation to the landscape quality and the heritage value of this area. Additionally, Côte Rhomara was designed as a RCP in 2012.

The RCP has an area of 68 km², whereas the SIBE occupies an area about ca. 42 km² and reaches a maximum depth of 8 m. This MPA is on the province of Chefchaouen, and is located between Oued Ouringa and the locality of Kaâ Sras. It is a trimmed and relatively inhospitable coast formed by a succession of small sandy beaches and rocky capes isolating a few islets at their base.

The best represented habitat of the MPA is similar to reefs (Habitat 1170) of the Annex I of the HD. A total of ten species of conservation interest appear occasionally on cliffs of this MPA such as Audouin's Gull, the Osprey and the European Shag (*Phalacrocorax aristotelis desmarestii*). Some species of the mesolittoral and infralittoral rocks are the macroalgae *L. byssoides* and *Peyssonnelia squamaria*, together with the Star Coral and Ribbed Mediterranean Limpet (Mateo-Ramírez et al. 2020c). In specific infralittoral rocky bottoms there are macroalgae communities with *Cystoseira compressa*, *Cystoseira humilis*, *Sargassum vulgare* and *Saccorhiza*

polyschides (UNEP-MAP RAC/SPA, 2009). In some sublittoral bottoms the Giant Tun (*Tonna galea*) can be relatively common unlike other parts of the Mediterranean Sea.

The main socio-economic activity of Côte Rhomara is the artisanal fishing, complemented with the growing tourism and its derived recreational activities. The main threat is the illegal fishing mainly that of bottom trawling that usually takes place near the coast of the regions Amtar, Chmaâla, Stihat and Targha. Nevertheless, there are other illegal types of fisheries in the area as the collection of Common Octopus in the area from Iâraben, and suspected dynamite fishing in the localities of Takamount / Sidi Ftouh. Another important threat is related to the development of the road network in the region (Mediterranean bypass), construction of residential or recreational areas and touristic coastal developments, that modifies the coastal line and increases the discharges of wastewater and litter.

6.6. Cirque d'El-Jebha SIBE and RCP (Morocco)

The Cirque d'El-Jebha was proposed as SIBE for its aesthetic value, scientific and educational interest and is currently part of the Intercontinental Mediterranean Biosphere Reserve Andalusia-Morocco. This SIBE occupies an area of 0.85 km² and reaches down to 27 m depth. In 2012, Cirque d'El-Jebha was also designated as a RCP with an area of ca. 3.6 km².

This MPA is located east of the city of Jebha, just after the fishing port, in the province of Chefchaouen, that is located in the Rif Central (Morocco). The Cirque d'El-Jebha is a horseshoe depression developed over a folded and trusted sequence of Jurassic limestones and Aquitanian turbidites (Vitale et al. 2015). The Cirque d'El-Jebha is a remarkable geomorphological structure, with an amphitheatre form limited by high cliffs and connected to the sea northwards. It is a very small rib, formed of a succession

of small sandy beaches, coves and rocky capes isolating a few islets at their base. A series of ravines cut the relief into very narrow valleys perpendicular to the coast.

In this MPA a high diversity of species has been detected, with 20 of them included in different conventions of protection (Mateo-Ramírez et al. 2020c). In their cliffs threatened birds nest such as the Audouin's Gull and the Osprey. The predominant habitat in this MPA is similar to the Reefs (Habitat 1170) of the HD. In steep cliffs and slopes and ledges exposed to waves and strong hydrodynamics, the mesolittoral community is conformed by cirripeds (Barnacle *Pollicipes pollicipes*), the red algae *L. byssoides* and other protected species such as the Ribbed Mediterranean Limpet and Saffian Limpet (Mateo-Ramírez et al. 2020c). In the subtidal zone other threatened species are the Star Coral, and some macroalgae such as *Cystoseira zosteroides*, *Cystoseira amentacea* and *Cystoseira elegans*. In the central part of the horseshoe depression, the seabed is composed of large blocks that host a very interesting biodiversity, including macroalgae such as *Dictyopteris polypodioides*, *S. polyschides* and *S. vulgare*, sponges like *Ircinia* sp., the Dusky Grouper, the Knobbed Triton as well as an important diversity of coralligenous communities with different corals and gorgonians such as the Red Coral, the Orange Tree Coral, the Violescent Sea-whip (*Paramuricea clavata*), the White Sea Fan (*Eunicella singularis*) and *Leptogorgia* sp. (UNEP-MAP RAC/SPA, 2009). Some of those aforementioned species are included in the Annex II of the BC. Small cetaceans such as the Common Dolphin have also been frequently observed in the area (Mateo-Ramírez et al. 2020c).

The Cirque d'El-Jebha has a high socio-economic importance for the town of Jebha. The proximity to the town and the port facilitates the artisanal fishing that exploits a wide variety of fishes (more than thirty species). Some of the target species are the very valued Dusky Grouper, Cuttlefish (*Sepia officinalis*), Common Octopus, Spider Crab

and the Spiny Lobsters (*Palinurus elephas*). The main threats are the increase of housing developments, as well as the urban discharges from the port and town that constitutes a source of significant contamination to the adjacent ecosystems. Other threats are the lack of wastewater and garbage treatment plants, the release of litter such as bottles, tires, ghost nets, etc. as well as the overfishing and illegal fishing, in particular of species included in conservation lists such as groupers and the Red Coral.

6.7. Cap des Trois Fourches SIBE and collateral protection figures (Morocco)

The Cap des Trois Fourches (Cape of Three Forks) was declared SIBE in 1996 and Ramsar Site in 2005 (CAR/ASP - PNUE/PAM 2012). Later, the terrestrial part was designated as RCP in 2012, with an area of 24 km². Finally, in 2014 a Réserve Naturelle was proposed, that included most of the terrestrial area of the RCP, and a maritime area of 68.2 km² ranging from coastal line to more than 230 m.

This MPA is located at the Trois Fourches peninsula, in the Moroccan commune of Beni Chiker (province of Nador) and north of Melilla (Fig. 21). This MPA is characterized by a cliff coast, containing small coves. In this area, the outcrop of two geological units occurs, separated by an extensional fault of NE-SW trend, towards the south of the fault micaschists with orthogneises, quartzites and marbles of Tarjât unit and lower greenschist shales and quartzites of the Taïdant unit, and to the north of the fault, calcano-alkaline series volcanoclastic rocks and detritic sediments of Tortonian age (Azdimoussa et al. 2019). One aspect to consider is the different physiognomy of the eastern and western coasts of the Cap des Trois Fourches. Due to the geological nature, the eastern coast is much steeper, with deep bottoms just few metres from the coast, but the western coast is smoother. This could also be related to the different hydrodynamics with stronger easterly winds compared to westerly ones.

Terrestrial ecosystems, without large human populations and minimal touristic influence, are rich and varied, with several habitats that are similar to those included in the Annex I of the HD. Some of the terrestrial habitats are Thermomediterranean and pre-esthetic scrubland (Habitat 5330), the most coastal Cliffs with vegetation on the Mediterranean coast with endemic *Limonium* spp. (1240) and Halonitrophile scrubs (Pegano-Salsoletea) (1430) (Mateo-Ramírez et al. 2020b).

The marine life of this MPA is influenced by the nutrient-rich waters and the biogeographic confluence of Atlantic species that are not common eastwards and of Mediterranean species that are not common westwards (González García 1994). This is clearly reflected in the algal communities, with the presence of the typical Atlantic algae *Fucus spiralis*, *Cystoseira gibraltarica* or *Gelidium sesquipedale* and of the typical mediterranean *Rissoella verruculosa*, *Cystoseira crinita* and the seagrass *P. oceanica*.

The first marine expedition in the Alboran Sea was carried out in 1910 by Odon de Buen, including the area of Cap des Trois Fourches to the Muluya river mouth (Camiñas 2018). The main marine habitats are Reefs (similar to Habitat 1170 of the HD), Submerged and semi-submerged caves (similar to Habitat 8330 of the HD) and Sandbanks which are slightly covered by sea water all the time (similar to Habitat 1110 of the HD) containing *C. nodosa* meadows (Mateo-Ramírez et al. 2020b).

In the mesolittoral reefs, well-preserved populations of the vermetid *D. lebeche* (Vulnerable) have been detected as well as of the limpet Ribbed Mediterranean Limpet (Critically Endangered), the latter with more than 20000 individuals (González García et al. 2006). In sublittoral rocky bottoms, protected or regulated commercial species occur such as the Common Antlers Sponge (*Axinella polypoides*), the cnidarians Star Coral, Pink Sea Fan, Violescent Sea-whip, Whip Gorgonian Orange Tree Coral, Yellow Tree Coral (*Dendrophyllia cornigera*), Mediterranean Pillow Coral (*Cladocora*

caespitosa), *Eunicella verrucosa*, *Eunicella gazella*, *Savalia savaglia*, *Leptogorgia lusitanica*; the molluscs Knobbed Triton, Rough Pen Shell, Zoned Mitre (*Episcomitra zonata*), Pear Cowry (*Zonaria pyrum*), Date Shell (*Lithophaga lithophaga*), Wandering Triton (*Ranella olearium*), Brown Cowry (*Luria lurida*); the crustaceans Spider Crab, Spiny Lobster, Slipper Lobster, European Lobster (*Hommarus gammarus*); the echinoderms Hatpin Urchin (*Centrostephanus longispinus*), Purple Sea Star (*Ophidiaster ophidianus*), Smooth Starfish (*Hacelia attenuata*); and the large fishes Dusky Grouper, Brown Meagre (*Sciaena umbra*) and Moray Eel (*Muraena Helena*), among others (Yus et al. 2013) (Mateo-Ramírez et al. 2020c).

Another interesting habitat of the MPA is the Kelp beds that are located in the most reophilic areas, specifically between “Los Farallones” and the tip of the “Farola” as well as in the vicinity of the “Tío Pinar” slab. The main kelp species are *S. polyschides* and *Phyllariopsis brevipes* that form extensive and dense meadows between 8 and 30 m depth with fronds up to 2 m high (González and Conde 1993). In the submerged and semi-submerged caves a rich fauna of invertebrates has been detected, especially in those of “Los Farallones” canal, the “Tío Pinar” slab, the tip of the “La Farola”, the “Puntilla” and “Cabo Viejo” (CAR/ASP - PNUE/PAM 2012).

In this MPA, some large pelagic species of marine vertebrates that are passing or stranding are common. Among fishes, the most singular ones are sharks (*Isurus oxyrinchus*, *Prionace glauca*), Bluefin Tuna and Swordfish (*Xiphias gladius*). There are some records of the Leatherback and Loggerhead Turtles and of cetaceans such as the Common Dolphin, the Stripped Dolphin, Bottle-nosed Dolphin, Long-finned Pilot Whale, Risso's Dolphin (*Grampus griseus*), Sperm Whale and the Fin Whale (Mateo-Ramírez et al. 2020c). Special mention deserves the Monk Seal (*Monachus monachus*), "Critically Endangered", of which, in the beaches of the volcanic caves of the tip of Cap

des Trois Fourches, resting specimens can be sporadically seen (Fig. 21) (Mateo-Ramírez et al. 2020c).

The main socio-economic activity in the MPA is artisanal fisheries. There are 70 boats from the village of Kahf Dounia, Tibouda and Ouled Lahsen that operate in the area. All of these use artisanal fishing gears and the target species are the Common Octopus, groupers, Axillary Seabream (*Pagellus acarne*), Albacore (*Thunnus alalunga*) and the Red Mullet (*Mullus surmuletus*). Another complementary and important activity is tourism. All year round, the fisherman rent their houses to tourists during weekends and in summer (CAR/ASP – PNUE/PAM 2012).

Human influence on the coast is still scarce, because the abrupt terrain of the MPA has not allowed important human developments that could threat the landscape. Nevertheless, three negative human activities should be mentioned such as the use of explosives for fishing that were carried out by the coastal population of “Cala Viñas” in the area of the “Farallones” during decades, which has reduced populations and sizes of large fish, especially groupers; the punctual bottom trawling and longline fishing carried out at short distance from the coast; and scheduled trips of one or several days of small vessels carrying underwater fishing experts that decisively influenced the decline of populations, especially of the Dusky Grouper, the Atlantic Wreckfish (*Polyprion americanus*) and the Goldblotch Grouper (*Epinephelus costae*). Nevertheless, this is something that seems already in decline, perhaps due to the decrease in the availability and size of large fish in the MPA.

6.8. Zona marítimo terrestre de los acantilados de Aguadú SAC (Spain)

The Zona marítimo terrestre de los acantilados de Aguadú SAC (Maritime-terrestrial zone of the Aguadú cliffs) (ES6320001) (Fig. 22) was designed as SCI in March 2006 and as SAC in September 2013, with a final area of ca. 0.55 km² (0.44 marine and 0.11

terrestrial). It is located in the northern part of the Melilla city, with an altitude of 120 m “Quemadero” ravine and a depth range between the coastline and ca. 30 m depth. On the land side, in addition to the aforementioned ravine, the cliffs of Aguadú occur from the seawater desalination plant to the border with Morocco, about 700 m of coastline. On the cliffs Messinian formations outcrops, from base to top, there is a succession of conglomerates, calcarenites, limestones of algae and breccia, and sands and silts, and finally covered by caliches and carbonate crusts of Holocene age.

Several habitats listed in Annex I of the HD can be identified in the SAC, with two of them being of marine character such as Reefs (Habitat 1170) and Submerged or semi-submerged marine caves (8330), and three terrestrial ones: Thermomediterranean and pre-steppics scrub (5330), Cliffs with Mediterranean coastal vegetation with endemic *Limonium* spp. (1240) and Halonitrophile scrub (Pegano-Salsoletea) (1430). In those terrestrial habitats, interesting vascular flora occurs such as the Thuja Articulata (*Tetraclinis articulata*) and *Helianthemum caput-felis* (protected in the HD) and the North African endemism *Bupleurum balansae*. In these areas, the Audouin's Gull displays a nesting population of several hundreds of specimens since 2015 (González García and Enrique Mirón 2018a) (Fig. 22) (Mateo-Ramírez et al. 2020b).

Regarding marine life, there are two protected molluscs associated with mesolittoral reefs with strong hydrodynamics (Habitat 1170 of the HD): the Ribbed Mediterranean Limpet (Critically Endangered UICN list), which forms dense populations of ca. 3000 adult specimens and a high number of immature specimens (González García et al. 2013, 2015; González García and Enrique Mirón 2019) and the vermetid (*D. lebeche*) (Vulnerable) conforming small groups of individuals or forming small continuous aggregates (González García et al. 2014). (Fig. 22) Other vulnerable protected species of the SAC are the Barnacle and the Saffian Limpet (Fig. 22). In addition, some

protected species of rocky-mixed bottoms, vertical walls, hollows or small caves at depths larger than 10 m (Habitat 8330 of the HD) are found in the SAC such as the Star Coral, the Knobbed Triton, the Rough Pen shell, the gorgonians Pink Sea Fan and *E. gazella*, the starfishes Purple Sea Star and Smooth Starfish, and the solitary Red Sea-squirt (*Halocynthia papillosa*) (González García and Enrique Mirón 2018b) (Mateo-Ramírez et al. 2020c).

This MPA has no human activities due to the prohibition and the restricted access and it has only been explored by the Spanish army for the last 15 years. The main threat comes from the desalination plant located in Punta de Rostrogordo that occupies 8000 m² at the foot of the cliffs located adjacent to the SAC. This desalination plant discharges the brine in the same area ("Overflow on a cliff", as defined in the CEDEX technical report for the Ministry of the Environment, Rural and Marine Affairs in 2011) (Fig. 22), as well as through an underwater outfall of 1 m in diameter at a depth of 9 m. Other substances are also discharged such as biocides, anticoagulants, flocculants, antifoulants, detergents, pH adjusters, etc. Currently, the project to expand the plant, already approved, with the further destruction of the habitat that this will imply, reinforces the threat. In 2005 and 2006, the works of the desalination plant (dredging, blasting and concreting, installation of pipes and a water tower, construction of a coastal breakwater, destruction of the cliff, etc.) and of a coastal road with anti-immigration purposes, caused a strong landscape and ecological impact, but, paradoxically, in the medium term and due to the total isolation of the human presence, the recovery of the diversity in 15 years has been very high.

6.9. *Sebkha Bou Areg SIBE and collateral figures of protection (Morocco)*

The Sebkha Bou Areg Réserve Naturelle (Nature Reserve) and RCP, also known as Mar Chica, is a coastal lagoon located close to Nador and Melilla that reaches 6 m depth, representing a unique formation within the Alboran Sea (Fig. 21). This lagoon is bounded to the east by the Gourougou volcanic massif, formed by pyroxene-biotitic andesites of a calc-alkaline series, to the north by rocky outcrops of Mesozoic and Neogene sedimentary units, while to the south by the plains of Bou Areg, constituted by marls and sandstones of Miocene and Pliocene age (Torcal Sainz and López Bermúdez 1997). It is separated from the open sea by a sandy littoral bar of about 24 km in length that is currently communicated with the sea through two channels or artificial “mouths” of about 300 m wide. The terrestrial area is a RCP declared in 2012 with 93 km². In 2014 the marine area was proposed as Nature Reserve, increasing the area up to 169 km² with 111 km² of marine area, with a maximum depth of ca 6 m.

In the littoral bar there is vegetation that is typical of coastal sandy beaches conforming some protected habitats that are similar to those of the Annex I of the HD, such as Annual vegetation on accumulated marine debris (Habitat 1210), Cliffs with vegetation of the Mediterranean coasts with *Limonium* spp. Endemic (1240), Mediterranean and thermo-Atlantic halonitrophilic thickets (*Sarcocornetea fruticosi*) (1420) and Halonitrophilic thickets (*Pegano-Salsoletea*) (1430) (Mateo-Ramírez et al. 2020b).

Sebkha Bou Areg was also declared as IBA by the BirdLife International Program in 2001 and SIBE and Ramsar Site in 2005. This was mainly due to its importance for biodiversity and breeding area, with nesting birds such as the Sandwich Tern, Pied Avocet, Marsh Harrier, Little Tern (*Sternula albifrons*), the Lesser Crested Tern (*Thalasseus bengalensis*) and the Kentish Plover (*Charadrius alexandrinus*). Other wintering and migratory species are the Little Ringed Plover (*Charadrius dubius*),

Black-tailed Godwit (*Limosa limosa*), Black Tern (*Chlidonia sniger*), Eurasian Curlew (*Numenius arquata*), Greater Flamingo (*Phoenicopterus roseus*) and Purple Heron (*Ardea purpurea*), among others (Fig. 21) (Mateo-Ramírez et al. 2020c).

Muddy sand occupies almost all of the lagoon bottoms, with the exception of the coast of the volcanic elevation of El Atalayón and the small sandstone formations of some areas of the littoral bar. Depth and sediment characteristics (e.g. organic matter concentration) determine the presence of different vegetated habitats such as small meadows of *Z. noltei*, meadows of *C. nodosa* and the macroalgae *C. prolifera*, sometimes mixed with those seagrasses (Habitat 1110 of the HD) (Fig. 21). Other macroalgae species proliferating in shallow areas of the lagoon with high salinity and clear signs of eutrophication are *Ulva rigida*, *Enteromorpha* spp. and *Chaetomorpha linum*. In boulders and small vertical barrels of the sleeve of El Atalayón, the vegetated habitats are conformed by furoid meadows (*C. crinita*, *C. compresssa* and *S. vulgare*) and other species such as *Gelidium pusillum*, *Laurencia obtusa*, *Spyridia filamentosa* or *A. acetabulum*, among others.

Animal diversity is reduced compared to the open sea, but there are some protected species that inhabit the lagoon, including the Rough and the Noble Pen shells, the latter until its decline in 2016 (Fig. 21), as well as the Long-snouted Seahorse (*Hippocampus guttulatus*), the Brown Cowry in sparse and only under sandstone cornices, the Captain Star (*Asterina gibbosa*) under stones in El Atalayón, the Mediterranean Pillow Coral and the Orange Puffball Sponge (*Tethya aurantium*). Other species are the Triple-grooved Shrimp (*Penaeus kerathurus*), abundant in freshwater outcrops of the internal part of the lagoon and the Eel (*Anguilla anguilla*) breeding in cane field ditches with agricultural discharges. Other marine species, most of them associated with macrophytes are the Holothurian (*Holothuria tubulosa*), the Shore Crab (*Carcinus*

maenas), Pink Cuttlefish (*Sepia orbignyana*), the Golden Grey Mullet (*Chelon aurata*), muricid gastropods (*Hexaplex trunculus*, *Bolinus brandaris*), nudibranchs (*Aplysia punctata*, *Pleurobranchaea meckelii*, *Berthella stellata*), epizoic colonial bryozoans of *C. nodosa* (*Botryllus schloseri*, *Botrylloides leachi*) and a wide variety of bivalve molluscs.

Regarding socio-economic activities, the MPA has been a fishing source of Triple-grooved Shrimp, Cuttlefish (*S. officinalis*, *S. orbignyana*), Common Octopus, Striped Seabream (*Lithognathus mormyrus*) and Sand Smelt (*Atherina presbyter*). In the 1980s, the MAROST Company introduced marine farms of various species in El Atalayón, including the Chequered Venus (*Ruditapes decussatus*), Kuruma Shrimp (*Penaeus japonicus*), Gilthead Seabream (*Sparus aurata*) and Common Oyster (*Ostrea edulis*). Tourism is concentrated on the coast of Nador and Beni-Enzar where the Melilla population spends their holidays.

The main threats are the increasing tourism pressure as well as the urban associated discharges and wastes of nutrients and herbicides from irrigated crops of the internal section between Nador and the southwestern end. There are also some invasive species such as the opisthobranch *Bursatella leachi*, the American Brine Shrimp (*Artemia franciscana*) or the Kuruma Shrimp which has displaced some native shrimp species. The future of the MPA remains uncertain because of the transformation that has already begun, which aims to transform the area into an extensive tourist complex. In this way, the disposal of urban waste has improved; two artificial mouths have been opened to the sea; important dredging have been done in the bottoms and the so-called “7 Cités de la Mar Chica” are under construction at the moment, with “marinas”, lagoons and artificial islets. This may represent an important threat for the persistence of some of the habitats and species of this MPA.

6.10. Islas Chafarinas National Refuge of Hunting & SAC (Spain)

The Chafarinas Islands are an archipelago that consists of three islands: Congress, Isabel II and Rey Francisco that located in the southern Alboran Sea, 48 km west of Melilla city and ca. 3 km in front of Cabo de Agua, and also located 11 km to the north-west of the Moulouya river mouth, very close to the border between Morocco and Algeria (Fig. 23). The presence of specimens of the Monk Seal (*M. monachus*) (Fig. 21), a large colony of Scopoli's Shearwater and Audouin's Gull, endemic flora species and well preserved bottoms communities, motivated its designation as National Refuge of Hunting (Refugio Nacional de Caza) in April 1982. Later on, these islands were declared as SPA in 1989. In November 1998 a SCI was proposed, approved in 2006 (ES6300001), and designated as SAC in 2018. Currently, these islands are under the shared administration of the Spanish Army and the Organismo Autónomo de Parques Nacionales (OAPN) of the Ministerio para la Transición Ecológica (Spanish Ministry for the Ecological Transition). These islands have been described as the eroded remains of a volcanic massif Upper Miocene-Pliocene in age (Barrera and Pineda 2006). These authors indicated the presence of mainly andesitic units from the calc-alkaline series (breccia, lava flows, domes and pythons) and basalts from the alkaline series. Covering these materials, carbonate crusts, hillside and eolic deposits appear, while the seabed is largely sedimentary due to the deposition of sediments transported by the coastal drift, predominantly westwards, from the Moulouya River (Barrera and Pineda 2006).

In this MPA, there are habitats included in the Annex I of HD such as *P. oceanica* meadows (Habitat 1120) displaying a healthy status, Submerged or semi-submerged marine caves (8330) and Reefs (1170) with interesting and rich associated benthic communities (Fig. 23) (Mateo-Ramírez et al. 2020b). The littoral and the sublittoral

bottoms harbour different species included in the Annex II of the BC, such as the critically endangered Ribbed Mediterranean Limpet, with one of the most important populations (Guallart and Templado 2016), the Hatpin Urchin, the vermetid gastropod *D. lebeche* or the Common Antlers Sponge, among others (Maldonado et al. 2011; Templado et al. 2016) (Mateo-Ramírez et al. 2020c). The peculiar characteristics of its waters, with a high degree of turbidity due to its proximity to the Ouad-Moulouya river mouth, enhance suspended sediment supply. This is probably one of the reasons for the presence at shallow waters of characteristic species of deeper areas such as the Whip Gorgonian, that display here the largest known population for the Alboran Sea (Maldonado et al. 2013) (Fig. 23), the black coral *Antipathella subpinnata* (Sánchez-Tocino et al. 2014), or the Gold Coral *Savalia savaglia* (Maldonado et al. 2011) (Mateo-Ramírez et al. 2020c). They are also remarkable the large populations of the Violescent Sea-whip and the presence of the Orange Tree Coral (Sánchez-Tocino et al. 2019) (Fig. 23) (Mateo-Ramírez et al. 2020c). Furthermore, a high species richness of molluscs has been highlighted by Oliver et al. (2015) in the bottoms around the islands.

Because the access to the islands is nowadays restricted, the only economic activity in the area is some small-scale fishing by Moroccan fishermen from “Cabo del Agua” and also some recreational fishing activity. This has been done both by Moroccan fishermen and the military detachment over several years, and it has caused significant damage on sessile benthic invertebrates. Some nets, lines and hooks have especially damaged the large Whip Gorgonian, with different colonies having fishing lines and pieces of net material tangled in their branches (Maldonado et al. 2013). On the other hand, the increase in spear fishing, due to the professionalization of the outstanding troops on the islands, resulted in a sharp reduction of large fish, especially groupers and sparids. Likewise, the lack of recycling by the Moroccan population of plastic bottles and litter

favours their accumulation in the *P. oceanica* meadows. Moreover, some mortality events of the gorgonians Violescent Sea-whip and White Sea Fan have been detected in recent years (de la Linde et al. 2018) (Fig. 23) and no living specimens of the Noble Pen Shell were found in 2019 due to the aforementioned massive decline of 2016. Finally, the presence of the invasive algae *C. cylindracea* and *R. okamurae* was confirmed in 2018 and 2019 (Sánchez-Tocino, personal observation).

The declaration of these islands as SAC and the regulation of fishing activities have been fundamental for stopping (or at least slowing down) the degradation of their habitats and associated communities. Nevertheless, in addition to these measures, it is necessary to intensify the surveillance to prevent the less visible areas of the islands from being used by Moroccan fishermen that throw their gillnets close to the coastline, by furtive underwater fishermen and for other types of activities that use the islands as an anchorage place, leaving the bottoms full of remains of their unsustainable activities (Fig. 23). At present, the increase in the breeding colony of Yellow-legged Gulls (*Larus michahellis*) seems to be affecting the Audouin's Gull, whose population is significantly decreasing.

7. Gaps of knowledge and future management ideas

The Alboran Sea is an area of importance regarding historical, social, geopolitical, strategic and scientific aspects, and it is the engine for different Mediterranean aspects. Its characteristic oceanography, as well as its strategic location, makes the Alboran Sea one of the areas with the greatest biodiversity in Europe and with a high amount of protected/threatened habitats and species, as it has been presented in this chapter. A natural marine heritage off the coasts of the southern Iberian Peninsula and northern Morocco and Algeria that should be protected in its entirety due to its uniqueness.

Nevertheless, its management and protection entails a difficulty arising from the need of designing a strategy of collaboration between different countries, which in this case belong to different continents and cultures. Therefore, in order to ensure the conservation of the biodiversity and the sustainable use of the resources of the Alboran Sea, it is necessary to adopt a coordinated management strategy based on different approaches including a network of Marine Protected Areas (MPAs), an Integrated Coastal Zone Management (ICZM), an effective plan for the protection and recovery of threatened and endangered habitats and species as well as a sustainable use of exploited resources (IUCN 2010).

7.1. Marine Protected Areas and Key Biodiversity Areas network

For consolidating the Marine Protected Areas and Key Biodiversity Areas (MPAs and KBAs), a network is needed for increasing the number and extension of MPAs as well as for implementing effective conservation measures in order to increase the protection of the Alboran Sea. The network should increase the number of MPAs in all surrounding countries, moving ahead to equilibrate the protected surface and the number of MPAs concerning the coastline length of each country. Currently the main problem to the sustainability of the good condition of the MPAs-KBAs is related to the needs for improving the human resources in relation to the control and surveillance in MPAs that is still inadequate regarding the number of officers and vessels for surveillance. A second gap is related to the lack of coordination and collaboration in terms of regulations and shared actions among local, regional, national governments and between countries.

It is remarkable the unbalanced number of protected areas between the northern and southern sectors of the Alboran Sea, because all MPAs-KBAs (including only IBAS) of

the Alboran Sea accumulate a total area of ca. 5661km², but ca. 91% belongs to those of the northern sector. The MPAs-KBAs network of the Alboran Sea is complex because MPAs-KBAs are very diverse from different points of view, both in terms of their conception and objectives, and in terms of their scope and responsibility for their management. It is important to distinguish between MPAs that are effectively protected and those that are in the process of improving their management (e.g. some KBAs, SCIs). There are only ca. 15 of the ca. 35 detected MPAs-KBAs (including only IBAS) that incorporate some protection figure and/or a management plan (Natural Park, Permanent Hunting Reserve, Natural Monument or Natural Site), which depends on the country where they are located. There are very few of them with effective protection measures. In parallel for increasing human and funding resources in the existing MPA-KBAs, the inclusion of new MPA or KBA should be accompanied of financial resources in order to provide surveillance and monitoring systems. Moreover, adequate infrastructures and services (e.g. waste water treatment plants, delimitation of restricted areas, etc.) should be provided in those areas where significant human developments and unsustainable practices are still occurring.

The current conservation and protection measures are not sufficient and it should be amplified and extended to all MPAs from the northern and southern Alboran Sea, which is especially needed for the MPAs of the southern sector. Moreover, there is a need for improving the integration and visibility of the Alboran Sea in the governance processes of the Mediterranean Sea, particularly those related to the Convention for the Protection of the Marine Environment and the Mediterranean Coastal Region (Barcelona Convention).

Furthermore, there are a high number of MPAs-KBAs that have not been explored in detail regarding habitat mapping, associated biodiversity, status of the populations of

endangered/threatened species, among other aspects. According to IUCN (2012) and the suggestions made by NGOs (e.g. Oceana) and marine experts, there are other KBAs that should be incorporated to the current MPAs-KBAs network such as the submarine canyons of Algeciras, Ceuta and Almería; the seamounts Banc de Xauen, Banc de Tofiño, Banco de Avempace, Banco de Djibouti Ville, Cabliers Coral Mound Province, Banco de Catifas or carbonate mounds of Melilla as well as others areas with poor current information (e.g. submarine canyon of Guadiaro or Almería, mud volcanoes of the Alboran Sea) or no information (the seamounts of Trois Fourches and Provençaux). In those areas, protected habitats and species have been reported by previous studies (Gil et al. 2009; de Mol et al., 2011; Pardo et al. 2011; Aguilar et al. 2013; OCEANA, 2014; Palomino et al. 2015; Corbera et al. 2019). Some of these habitats are reefs formed by cold-water-corals (harbouring protected species such as *Madrepora oculata*, *Desmophyllum pertusum*, *Dendrophyllia ramea*, among others), gorgonian and black coral aggregations (with protected species such as *Callogorgia verticillata*, *Antipathes dichotoma*, *Leiopathes glaberrima*, among others), sponge aggregations, sea-pen and bamboo coral communities, as well as protected species of elasmobranches (*Oxynotus centrina*, *Centrophorus granulosus*, *Leucoraja circularis*, *Cetorhinus maximus*, and *Squalus acanthias*) and molluscs such as Giant Oysters (*Neopycnodonte zibrowii*). In order to incorporate those new areas to the current MPA-KBA network, the relationships between administrations and scientists of each country and at regional level should be created if necessary, or at least improved. For example, the communication of the results obtained by the scientists to managers and policy-makers concerning new results, additional needs and new proposals of protected areas, should be done in an easier and more didactic way.

7.2. Conservation of habitats and diversity

Regarding cetaceans, it would be essential to implement the recommendations of the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and Contiguous Atlantic Area (ACCOBAMS), of which both Spain and Morocco are members. A management plan for cetaceans in the entire Alboran Sea, which has been identified by ACCOBAMS and IUCN as an "Area of Conservation Interest", should be implemented. Experts also recommended the implementation of management plans already developed for the Bottle-nosed Dolphin and the Common Dolphin. In 2007, Spain requested that ships crossing the Strait of Gibraltar may not exceed the speed of 13 knots, with precautions during those months when Sperm Whales return to the Strait of Gibraltar for feeding (UCIN 2007, 2010).

In relation to marine turtles, a "Strategy for the conservation of the Loggerhead Turtle (*Caretta caretta*) and other marine turtles in Spain" is under elaboration under the framework of the Action Plan for the Conservation of Mediterranean Marine turtles (Barcelona Convention, BC) and for the fulfilment of the commitments established by other international conventions ratified by Spain such as OSPAR, Bonn and Bern. The MITECO, through the General Directorate for Sustainability of the Coast and the Sea (DGCSM) and the regional and autonomous city governments are preparing this national strategy, drafting the basic technical document within the Working Group of Marine turtles of the Committee of Wild Flora and Fauna. The Spanish Strategy should be reviewed by the State Commission for Natural Heritage and Biodiversity. There are some other national initiatives for the Loggerhead Turtle which includes limiting accidental catches by fishing gear. Nevertheless, this action plan is not yet being applied because of the lack of approach between the different parts involucres (UICN 2007, Robles 2010).

For the Monk Seal, there is a need for reducing significantly human impacts and affluence in some MPAs and create new MPAs that may harbour the habitats and resources needed for the establishment of Monk Seal populations, both in the southern and northern Alboran Sea.

Some habitats are experiencing a current decline (e.g. seagrass beds on soft bottoms, Sea-pen-bamboo coral communities) (Waycott et al. 2009; Fabri et al. 2014) and there is a need to achieve their recovery through restocking in specific areas, and effective conservation of the remaining patches of such habitats. For an effective conservation, water quality should be improved, illegal bottom fishing should be controlled as much as possible, boats should be prevented from anchoring on them and coastal erosion should be mitigated (IUCN Grupo de Coordinación Alborán).

The MPAs-KBAs network of the Alboran Sea, even though, seem to present a good representation of habitats from the Habitat Directive and Barcelona Convention, such as *Posidonia oceanica* beds (Habitat 1120 of the HD), Reefs (Habitat 1170) or Sandbanks which are slightly covered by sea water all the time (Habitat 1110), there are others such as Submarine structures made by leaking gases (Habitat 1180) and Caves (8330) that are still underrepresented. Subtypes of the Habitat 1170 such as Cold-water Coral reefs or antipatharian aggregations are also not well represented, The inclusion of new MPAs-KBAs that may have these habitats (e.g. mud volcanoes of the Alboran Sea or the Cabliers Coral Mound Province with the biggest CWC reef of the Alboran Sea), would help to increase the conservation of these habitats in the MPAs-KBAs Alboran network.

Regarding habitats with good representation, the lack of updated habitat mapping for the total Alboran Sea still represents a key factor for its effective conservation and management (Rueda et al. Chapter 9 of this volume). Some projects (e.g. LIFE +

INDEMARES, LIFE+ *Posidonia* Andalucía, LIFE Blue Natura, etc.), have done significant efforts for improving habitat mapping in specific areas, but accurate mapping is generally absent in most MPAs-KBAs, and even for priority habitats such as *P. oceanica* beds. This kind of information is essential for a good management and Marine Spatial Planning that can ensure the effective conservation of the habitats.

Inclusion of new MPAs-KBAs as mentioned in the previous section as well as effective conservation of the populations in the already designated MPAs-KBAs would also improve the connectivity between populations of threatened species. The number of protected species in MPAs of the Alboran Sea is relatively high but it is remarkable that most of them are for vertebrates, particularly birds and mammals (cetaceans), probably because invertebrates and macro algae despite its undeniable importance for ecosystems, have less interest to the general public and always been underrepresented in official conservation lists. Some invertebrate species such as gorgonians, corals or sponges are slow-growing organisms with a low reproductive output that are very threatened. Some of them provide shelter, food provision and nursery habitats to a wide variety of species, but most of them are still not included in national conservation lists. Moreover, there is a need for increasing the knowledge on the biology and ecology of some of these invertebrates as well as on their resilience to human impacts (Templado et al. Chapter 10 of this volume). Regarding this, it is important to create a hub of research and knowledge on marine biodiversity between local, regional, national governments as well as between countries, including new projects based on research, ecosystem management, transfer of information, education / awareness and on the integration of the experiences of different sectors that use each MPA and KBA.

7.3. Sustainable exploitation of the resources and main threats

The fishing resources from the Alboran Sea are managed under the framework of two Regional Fisheries Organisation (RFOs): the General Fisheries Commission for the Mediterranean (GFCM) and the International Commission for the Conservation of Atlantic Tunas (ICCAT). The main aim is achieving a sustainable management of the different exploited resources. All countries surrounding the Alboran Sea are members of these two RFOs and therefore they are involved in the implementation of joint regulations and agreements adopted by the parties aiming to the protection of the tuna and tuna like species (ICCAT) and to the demersal and small pelagic species and respective fisheries. Unfortunately there is no automatic compliance with all regulatory measures adopted by the RFOs and, if these measures are translated into national regulations, the existence of the necessary means, tools and human resources to verify and control the implementation is still lacking.

Although important progress have been made for the conservation of the Alboran Sea, it is necessary to improve the role of political and social (e.g. fishermen) sectors towards the environment and sustainable development.

The status of most of the Mediterranean exploited resources stated that ca. 78% of the stocks assessed, including stocks of all priority species, were overexploited (FAO 2018). This percentage has slightly decreased since 2014 (88%), which reflects the different recent management measures that have been made, but underlines the need to go further. Nevertheless, the last GFCM Report 2019 (FAO 2020) underlined that ca.11% of the Mediterranean stocks assessed were considered sustainably exploited while 80% of the stocks were considered to be outside biological safe limits. In particular, European Hake (*Merluccius merluccius*) was found to be the most exploited species in the Mediterranean Sea and current measures (minimum landing size, mesh size, etc.) were found to have been ineffective for reducing the overexploitation. The

overexploitation of fishery resources is also affecting the biodiversity in relation to discards as well as to sensitive habitats (e.g. *Posidonia* meadows, coralligenous communities, etc). The majority of the fisheries operating in the MPAs of the Alboran Sea use small scale-gears, although medium bottom trawl vessels and some purse seiners and trammel nets are illegally operating on some algae and *Posidonia* meadows of these MPAs, impacting these communities and the stability of the ecosystems. Small scale fisheries are considered the most appropriate methods to be substantial and to extract fishery resources and management plans of the MPAs have to include the local fishing communities. The idea is the implementation of strategies of adaptive management based on the application of: a) regulatory measures and fleet management, with well-defined objectives and with sufficient and continued funding; b) integrated coastal zone management and c) an ecosystem approach in relation to the biology and life cycle of commercial and threatened species and interactions among them, effects of climate change on stocks and fisheries, relationships between coastal and deep-sea stocks, define appropriate biological units of management, between others (Robles 2010). For example, in Al Hoceima National Park (Morocco), innovative and effective strategies have been incorporated such as a funding system for the conversion of some fishing gears or diversification of fishermen's income (fishing tourism, whale-watching, etc), establishment of the Observatory of Al-Hoceima (ODYSSEA) and the adoption and implementation of the EU Marine Strategy Framework Directive (MSFD), among others (Nibani 2019).

Summarizing, the fundamental weakness that prevents an improvement of fisheries, is the lack of the real implementation of the important regulatory measures, together with a lack of integration in co-management schemes at all levels (national, regional and especially at a more local level) (UICN 2010).

An interesting way for controlling illegal fishing inside the MPAs, as well as productivity of some fishes (e.g. groupers) is the use of artificial reefs whose purpose is, on the one hand, to exercise passive surveillance against illegal fishing and, on the other hand, to provide shelter and protection for marine fauna. For example some MPAs of the northern Alboran Sea (e.g. Natural Park of Cabo de Gata-Níjar or Paraje Natural de Acantilados Maro-Cerro Gordo) deployed artificial reefs and detected promising results on the fish communities as well as in the number of illegal fishing lines and nets entangled in these reefs (Junta de Andalucía 2017). The artificial reefs are a very valuable tool for passive surveillance. In this sense, there is also a need for more collaboration between organisms in order to have more complete and effective reefs, and not only for fishing purposes. The installation of artificial reefs around all MPAs of the Alboran Sea could be a way for supplying the lack of surveillance systems, especially for those MPAs from Morocco and Algeria coast.

Generally speaking, the tourism system is based on mass tourism and, sometimes, has limited impact on the local economy. These tourism activities are environmentally unsustainable because they bring with them economic problems (income fall, over construction of infrastructures, etc.), environmental (loss of natural areas, decrease/disappearance of species, etc.) and socio-cultural (loss of cultural identity, increased illegal activities, etc.) (UICN 2010). This kind of tourism should be reconsidered in the MPAs.

Pollution (e.g. sewage, oil spills, litter) is still one of the most important threats for some habitats (e.g. vegetated habitats) and species, particularly the derivative from dangerous substances or outdated chemicals. The number of waste water plants and the effective treatment of these waste water plants should be improved, as well as regulations minimize the use of non-degradable plastics. However, the high

concentration of PCBs and DDTs found in the population of Common Dolphin is another important indicator (UICN 2010). In the southern Alboran Sea, more wastewater treatment plants are also urgently needed (Colloca et al. 2003).

Invasive species represent a recent main threat for MPAs-KBAs of the Alboran Sea, and some of these species are increasing due to the global change and deterioration of the ecosystems. For example the recently expansion of the exotic invasive algae *Rugulopteryx okamurae*, throughout the northern and southern sectors of Alboran Sea, has generated huge problems by displacing native macroalgae species (with further effects on the ecosystem), producing important losses to the artisanal fishermen, and finally affecting the native biota associated to photophilous bottoms. The tourism has also suffered consequences because hundreds of tons of the alga upset the beaches and even the underwater system used by the desalination plant in Marbella (Spain) had troubles due to the massive growth of this brown algae. The main way of introduction of these invasive species seems to be due to maritime traffic (commercial and recreational). It is essential to provide the necessary elements for the control of the introduction and/or reintroduction of invasive alien species by adopting a specific code of conduct according to the Code of Practices (1995) of the International Council for Exploration of the Sea, the lines of action (1994) of the International Maritime Organization on ballast water and fouling, and the Precautionary Approach of FAO (1996) (UICN 2010).

7.4. Management measures

In 2006, the IUCN decided to start an initiative with the aim of achieving better conservation and sustainable development in the Alboran Sea. The long term objective of this analysis was to create the conditions and to construct the basis required for the

establishment of co-ordinated management of the Alboran Sea (Robles 2010). This initiative had the support of the Málaga Provincial Council, the Agence de Développement de l'Oriental (Morocco), Instituto Español de Oceanografía (Spain) and the Institut National de Recherche Halieutique (Morocco). Different meetings have been made in Spain (Barcelona 2008) and Morocco (Oujda, 2009), as well as projects such as POCTEFEX-Alboran (Spain, Morocco and Algeria, 2012-2014) or fisheries projects such as CopeMed I-II (2009-2020). During the POCTEFEX-Alboran project, some progress was achieved for the establishment of an Alboran conservation and sustainable development technology platform (Geoportal of Alboran Sea), meetings of artisanal fishing entities (e.g. in Alhoucemas in 2014), cooperative working groups (biodiversity, MPA and Integrated Coastal Zone Management), and initial assessment of the Cap des Trois Fourches, in accordance with the MSFD, among others.

Recently, two projects have promoted the implementation of the ecosystem approach (EcAp), in coherence with the MSFD and in the context of the BC (EcAp-MED I-II, 2010–2019). The first initiated the EcAp roadmap, especially in relation to the development of an integrated monitoring and assessment programme for the Mediterranean. Whereas the second have provided assistance to the Southern Mediterranean contracting parties to the BC for implementing the EcAp (https://www.rac-spa.org/ecapmed_ii).

Significant steps with important efforts have been done and much progress has been made in scientific knowledge about habitats, species, threats, etc. affecting the ecosystems. Nevertheless, there is still a weak coordination between national and international agencies that may result in negative effects on the conservation and management of some MPAs-KBAs, generally due to the complex existing legislation regarding competences in the marine part (e.g. Alboran Island). For such reason, further

collaboration within local, regional and national governments of the countries around the Alboran Sea as well as of the different sectors exploiting its different resources (e.g. fisheries, tourism industry, etc.) is urgently needed in order to switch for an effective conservation of the Alboran Sea natural heritage.

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