Habitat and Endemic Species

Greece scale

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Co-Evolve4BG

Analysis of Threats and Enabling Factors for Sustainable Tourism at Pilot Scale

Habitat and Endemic Species

Greece Scale

REGION OF EASTERN MACEDONIA & THRACE

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OVERVIEW

The present document was produced in the framework of **Co-Evolve4BG** project "*Co-evolution of coastal human activities & Med natural systems for sustainable tourism & Blue Growth in the Mediterranean*" in relation to Threats and Enabling Factors for maritime and coastal tourism development on a national scale" Co-funded by ENI CBC Med Programme (Grant Agreement A_B.4.4_0075).

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REVIEW

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Abstract

This deliverable aims to integrate research and record all the existing resources related to habitat and endemic species in the Mediterranean region, especially on the Greece scale. Furthermore, it will present an overview of the past, current, and future trends of their evolution. It will highlight the effect of climate change and anthropogenic pressures on habitat and endemic species. In addition, it will cope with the relation between Habitats and endemic species with the development of tourism.

The Environment and Development Conference (widely known as the Rio Summit or Earth Summit) under United Nations was conducted in 1992 and was concluded in the Convention on Biological Diversity (CBD). On a global scale, it was the first official recognition of the emerging necessity for implementing an international policy and relating actions and the worldwide establishment of biodiversity.

The geographic location of Greece, in combination with the climate, sea temperature, limited coastal construction and unique geomorphological landscape with thousands of islands and many wetlands (shown in Figure 15 in Annex I), force the creation of a vibrant fauna and flora biodiversity, extensive habitats, and a high level of endemism. Greece is located at a crossroads between three continents: Europe, Asia, and Africa. It is the Southeast part of Europe with a lengthy coastline and extensive coverage of natural and semi-natural habitats consisting of more than 50 % of the national region. Primarily, this 50 % divided into the forests and wooded areas 33%, grasslands 13%, scrublands 21%, water and wetlands surface 2%, and bare land 3%. Greece, except for the richness of fauna and flora, is characterized by a large number of species of fungi. In general, in Greece, a high proportion of the country's species are highly endemic, which means that they are found nowhere else in the world.

Statistics have shown that plants in Greece account for 5,752 species and additional 1,893 subspecies of vascular plants (Fig. 6). Because of the 1,278 endemic (22.2% of all species present) and 452 plants of endemic subspecies, Greece is considered one of the world's hotspots from a biodiversity standpoint.

The Greek fauna is also considered very rich. Until today, 23,130 animal species have been recorded in continental, marine and coastal ecosystems. Of these, 3,956 are endemic to Greece, and other 3,500 animal species recorded to habit in the marine environment. Unfortunately, 14% of all recorded vertebrate species in Greece are listed as endangered (Conference, International, and Education Geneva, 2004).

However, the biodiversity of the Mediterranean region and especially Greece is particularly threatened by human activities as one of the most popular tourism destinations. Greece is an intensively developed region; thus, it is exposed to a broad spectrum of anthropogenic impacts.

However, tourism is the “heavy” industry for the Greek economy and the central pillar for tourism development is the unique natural environment and primarily the coastal zone with beaches. In addition, natural ecosystems are considered a fundamental element of modern human wellbeing, public goods such as clean air, water, soil, and fisheries are also included. So, biodiversity preservation and sustainable use are of paramount importance for Greece, including decision-makers and the public. For the following years, a significant challenge is how Greece could achieve sustainable management of ecosystems and green growth, preserving and protecting the fragile ecosystem with the rich biodiversity to be under threat, in balance with an eco-friendly touristic product.

I. Overview of habitat and endemic species

Greece is located at the crossing of three continents (Europe, Asia, and Africa) and characterized by a tremendous topographic variability (a considerable number of islands, significant variation in the landscape from marine to mountainous over small distances, numerous rivers, gorges, valleys, peninsulas, *etc.*). Greece has complicated geological and geomorphological formations (including caves). It has a broad array of soil forms (entisols, inceptisols, alfisols and vertisols). In addition, through the rich history and until recently, poor, and sustainable human interaction with the natural environment has shaped today's semi-natural vegetation formations. Connecting all these characteristics has contributed to the country's extraordinary biodiversity and extensive habitats (Fig. 1). What is more, a high proportion of the country's species is unique worldwide, *i.e.*, high endemism.

The seafloor of the Greece seas and particularly in the Aegean Sea, has a significant number of marine lives, extensive flora, and fauna. From the surface of the sea to the continental shelf, four bathymetric zones are recognized. The Supra-littoral and Medio-littoral are the two first zones corresponding to the intertidal system, which are very narrowly and characterized by the small range of tides in the Aegean Sea. The other two zones, next to them, are the Infralittoral and Circalittoral, which correspond to the subtidal photic system, which is characterized as very large, due to the great transparency of the sea water.

The infralittoral zone is continued down to 40 m depth, with the meadows of the endemic Mediterranean seagrass *Posidonia oceanica* to be the dominant habitat on soft beds. On rocky infralittoral bottoms, a plethora of macroalgae is present, with the brown algae of the emblematic Mediterranean taxon *Cystoseira* to be the dominant element of the benthic vegetation. Down to a depth of 120 m where favourable hydrodynamic situations exist, the circalittoral zone begins. The calcareous red algae of the Corallinales taxon form well-structured "maerl-type" or rhodolith biological communities and are extended. Both seagrass meadows and "maerl-type" beds habitats are considered from a biodiversity perspective as hot spots.

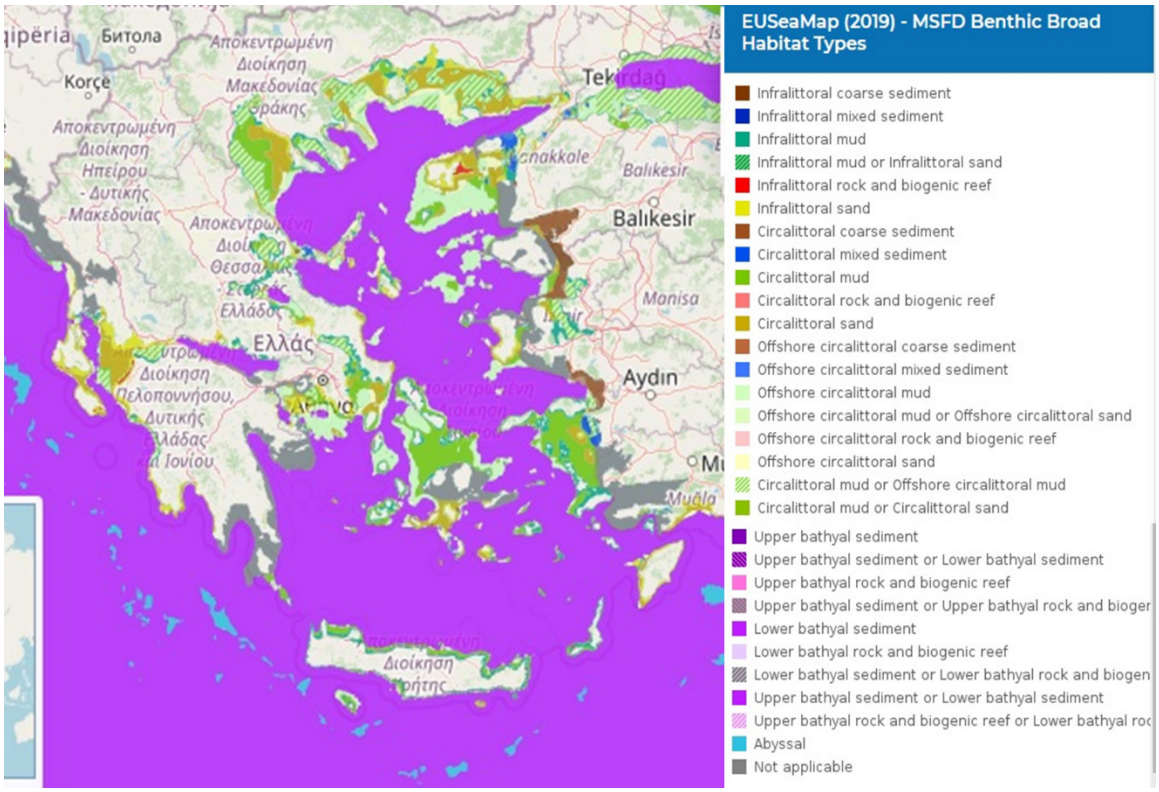

Figure 1. Benthic Broad Habitat Types (emodnet.ec.europa.eu)

II. Data collection

II.1. Terms and Definitions

It is essential to define from the beginning the core terms and definitions of this deliverable (3.1.1.8: Habitat and Endemic Species – Greece Scale), to familiarize the readers with these contexts, so the basic terms and definitions are:

- **Biological diversity,** generally referred to as **biodiversity**, defined the full range of structures of life, such as plants, animals, and micro-organisms. Including all levels of life from the lowest, the genes they contain, to the highest, the ecosystems they form. The term biodiversity covers all Earth's life forms.
- **Biodiversity** is generally applied at three levels: genetic diversity, species diversity, and ecosystem diversity. These three levels correspond to the three primary and taxonomy levels of biological organizations.
- **An ecosystem** is used to define a dynamic and complex functional unit of plants, animals, and microorganism communities, including their interaction with their non-living environment.
- **Habitat** is referred to as the spot or the biotic and abiotic conditions where an organism or population naturally exists or could potentially be created. However, European Directive 92/43 defined **habitat types**, which named distinct terrestrial or aquatic areas by vegetation elements, dominant flora, and abiotic characteristics.
- **Endemic** is defined as the species that only inhabit a specific and restricted geographical area.
- **A protected area** is called a specific geographically defined area determined or regulated and managed to achieve specific preservation scopes.
- **Sustainable use** has defined the mode of use of the elements of biological diversity are in a proportion that will not lead, in the short or long-term, to a reduction of the existing biological diversity; thus, maintaining its potential to satisfy the needs and goals of present and future generations.
- **Direct threats** for preserving species and ecosystems are defined as the human activities that have been or are the cause of biodiversity loss or degradation or those activities that hinder ecosystem functions.
- **Invasive alien species** are the **non-indigenous** or **non-native** species introduced in a specific geographical area outside their indigenous range. They can survive and settle in nature by inhabited vital territory in natural ecosystems and displacing native species or even biological communities.

- **Red List** of Threatened Species (broadly known as IUCN Red List or Red Data List) is a catalog of the global conservation status of biological species (plants, animals, and fungi) produced by countries or organizations to have a tool to assess the level of risk of extinction of species within their sovereignty.

II.2. National Biodiversity Strategy and Action Plan

National Biodiversity Strategy and Actions Plan – NBSAP for Greece was public in 2014. Its 6th National report was renewed and published in December 2019 by the Ministry of Environment, Energy, and Climate Change. The 6th update was an obligatory modification of the earlier recommended strategy to the Aichi objectives and the EU Biodiversity Strategy for 2020. The overall targets for installing the appropriate indicators for monitoring and evaluating its implementation have been established and are working.

The NBSAP orient the following (Ministry of Environment, Energy & Climate Change 2014):

1. *Scientific data* about the wealth, value, and influences to the biodiversity in Greece
2. *Legal frame*, at national, European, and international levels, contemporaneously with European Directives and International Treaties.
3. *The Strategic frame* is determined by several national, European, and international reports that Greece participates in and adopts.
4. *General policies* that are viewed a priori acceptable since they arise from moral values, national needs and capacities, and complimentary scientific procedures.
5. *Integration of preservation and sustainable growth* into a national policy frame.
6. *Preservation and strengthening of actions* aiming at protecting biodiversity throughout the national region.
7. *Long-term preservation of biodiversity and its function*, as well as the fair and equitable sharing of its benefits.

The Greek NBSAP was adopted as a Ministerial Decision and published in the Official Journal of the Government (FEK 2,383 B / 08 September 2014).

II.3. Projects and Initiatives in Greece

According to the European Common Database of Designated Areas, it is estimated that about 12% of the land area is considered protected. Furthermore, there are 163 Special Protection Areas (SPAs) according to the Birds Directive. In addition, official recorded 239 Sites of Community Importance (SCIs) have been covered in the pan-European network Natura 2000, embracing more than 21% of the terrestrial portion of the country and 6% of the national territory of the sea. Twenty-seven Management Bodies have been verified in many protected sites and SPAs and SCIs around the country.

Critical protected species (*e.g.*, *Caretta caretta*, *Monachus monachus*) have focused on action plans and LIFE-Nature projects with high-grade outcomes.

Recording genetic resources has maintained with endemic plant varieties, herbal and medicinal plant species. Since 1981, the Greek Gene Bank manages more than 14,000 samples of seeds or clonal generative material, referring to 169 species of crops or their wild-growing relatives in its facilities of seven plantations. Moreover, implementing the Nagoya Protocol has revitalized the effort to install a comprehensive national framework that will offer a regulation for access and sharing of genetic resources (CBD 5th National Report).

II.4. Data Collection

Greece belongs to the European Union and participates in almost all global organizations such as OSCE, UN and others. Moreover, it has signed all the treatments regarding the conservation of the environment and promotes the planet's sustainability. So, there are several databases where data regarding the Greece marine ecosystem can be found. European Environment Agency, EMODnet Seabed Habitats, Eurostat, and several other non-governmental organizations actively promote the marine ecosystem in Mediterranean Sea and Greece by gathering data and conducting scientific research.

Primarily, for this deliverable, the Greek NBSAP provided most data and additionally, the above sources, which are complete the NBSAP 6th final edition:

- Information was reported to the European Commission in implementing the European Environmental Policy (Vasiliki and Hadjicharalambous, 2008).
- Information included in biodiversity-related National Reports to other organizations and authorities (Stavropoulos *et al.* 2006).
- Information included in biodiversity-related National Strategies (draft National Biodiversity Strategy, Greek Strategy for a Sustainable Management of Farm Animal Genetic Resources)
- Information included in National Operational Program 2007-2013 "Environment and Sustainable Development".

In addition, several global and regional datasets that store and maintain a critical part of the Mediterranean and Greek Seas information have been used. These databases were from the World Register of Marine Species database (WoRMS), Marbef Data System (European Register of Marine Species, ERMS), and the Ocean Biogeographic Information System (OBIS) FishBase and SeaLifeBase, AquaMaps, and ICTIMED.

II.5. Legislation for Marine Ecosystem Conservation

Legislation for the marine conservation policies and management, which are acting directly or indirectly, includes international agreements and conventions, regional agreements and intergovernmental sectoral agreements, and European directives and policies (Project MARCONS, 2018). This legislation provides the basis for an inherently interdisciplinary cross-sectoral approach to conservation policy analysis and preserving the habitat and endemic species. For the needs of this deliverable, the legislation divided into three parts: global, regional and European Union level, which are:

Global level

- United Nations Convention on the Law of the Sea (UNCLOS)
- UN Agreement on Straddling Fish Stocks and Highly Migratory Fish Stocks
- Convention for Biological Diversity - CBD
- Convention on International Trade in Endangered Species of Wild Fauna and Flora - CITES
- Convention on the Conservation of Migratory Species of Wild Animals (Bonn Convention) – CMS
- Convention on Wetlands of International Importance, especially as Waterfowl Habitat (RAMSAR)
- World Heritage Convention – WHC
- International Convention for the Regulation of the Whale - ICRW (1946) and following instruments from the International Whaling Commission (IWC)
- Code of Conduct for Responsible Fisheries UN Food and Agriculture Organization (FAO)
- Revised Guidelines for the Identification and Designation of Particularly Sensitive Sea Areas (PSSAs) International Maritime Organization (IMO) Resolution A.982(24)
- International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM Convention) International Maritime Organization (IMO)
- Convention on the Protection of the Underwater Cultural Heritage - UNESCO
- World Bank environmental & social framework

Regional level

- Protocol on the protection of the marine environment of the Black Sea from land-based sources
- Protocol of the Bucharest Convention
- Annex 1 of the Biodiversity and Landscape Conservation Protocol (2002) of the Bucharest Convention (1992)

- Annex 3 of the Biodiversity and Landscape Conservation Protocol of the Bucharest Convention
- Strategic Action Plan of the Bucharest Convention
- Convention for the Protection of the Marine Environment of the North-East Atlantic – also known as the Oslo and Paris Convention (OSPAR)
- Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention, 1992)
- Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention, 1976, amended 1995)
- Protocol concerning Specially Protected Areas and Biological Diversity in the Mediterranean (1982 amended 1995)
- Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention, 1979)
- Agreement on the Conservation of Cetaceans of the Black Sea, the Mediterranean Sea and Contiguous Atlantic Area - ACCOBAMS
- Agreement on the Conservation of Small Cetaceans in the Baltic, Northeast Atlantic, Irish and North Seas - ASCOBANS
- European Free Trade Association (1960) - Agreement on the European Economic Area (EEA)
- Agreement on the European Economic Area - EEA Agreement
- Euro-Mediterranean agreement
- General Fisheries Commission for the Mediterranean - GFCM recommendations
- Northeast Atlantic Fish Commission - NEAFC convention

It is worth mentioning that Greece is not concerned by the ASCOBANS agreement, however, it is concerned by the NEAFC convention.

European Union level

- Habitats Directive - Council Directive 92/43/EEC of 21 May 1992.
- Birds Directive - Directive 2009/147/EC of the European Parliament of 30 November 2009.
- Marine Strategy Framework Directive 2008/56/EC.
- Water Framework Directive 2000/60/EC (WFD).
- Maritime Spatial Planning Directive (2014/85/EU).
- Directive 2014/52/EU of the European Parliament and of the Parliament of 16 April 2014 amending Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment.

- Strategic Environmental Assessment Directive (Directive 2001/42/EC).
- Common Fisheries Policy, Regulation (EU) No 1380/2013 and amending Council Regulations (EC) No 1954/2003 and (EC) No 1224/2009 and repealing Council Regulations (EC) No 2371/2002 and (EC) No 639/2004 and Council Decision 2004/585/EC.
- Renewable Energy Directive (2009/28/EC) and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.
- Urban wastewater treatment directive (91/271/EEC).
- Nitrates Directive (91/676/EEC).

III. Identification of habitat and endemic species threats and their impacts on coastal ecosystems

III.1. Identification of Habitats

Greece's coastline is extremely extensive and exceeding 18,000 km, which is the longest in the whole of Europe. Greek seas and the northeastern Mediterranean present significant low levels of coastal development compared to the Western Mediterranean, making the littoral/coastal zone ecosystems (Fig. 2) one of the highest biodiverse marine zones of the entire Mediterranean basin. At the same time, it is considered a vast region for species settlement. The area has shallow waters, where the sunlight can reach the sea bottom.

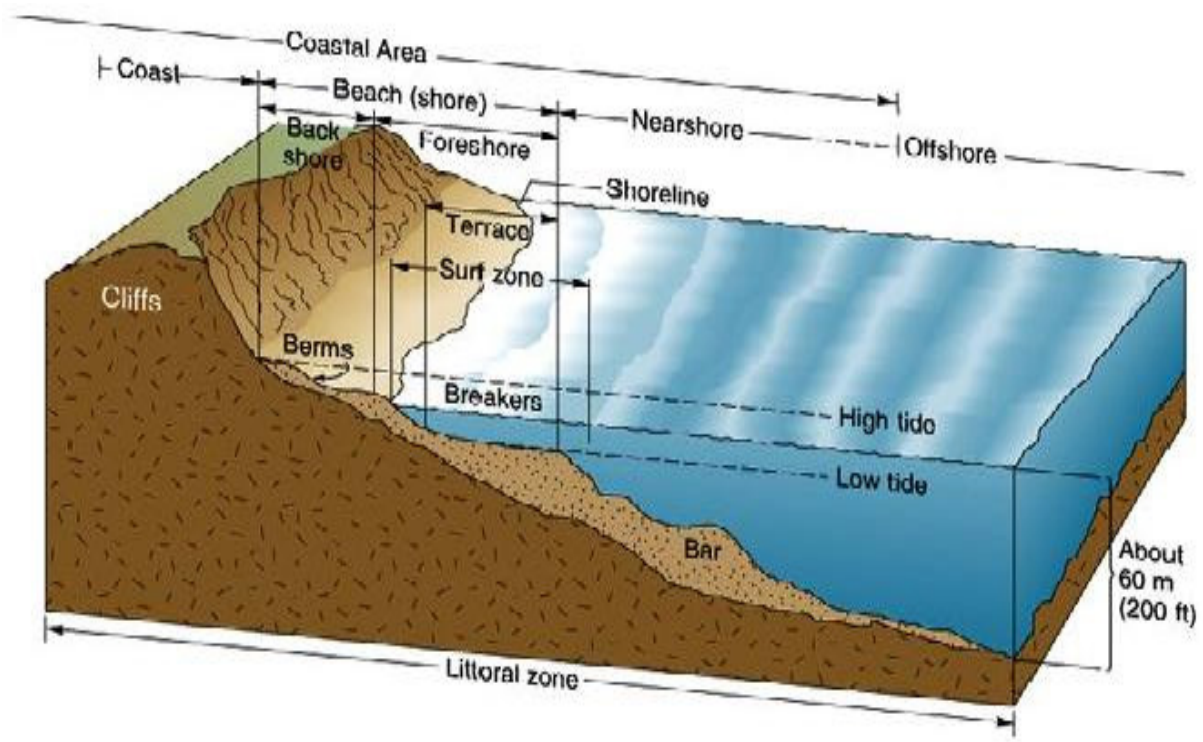

Figure 2. Littoral Ecosystems (The coastal Ecosystems - Archipelagos)

Monitoring of the littoral/coastal zone in Greece observed a great variety of different species. Here is an overview of the various groups followed.

Algae (photosynthetic organisms) are an incredibly diverse group ranging from single-celled organisms to giant kelp that can reach 65m in length. The Greek seas recorded 550 algae species, forming most food webs in the littoral/coastal ecosystems. This

occurred because of their ability to convert sunlight into energy that other marine organisms can utilize at higher trophic levels. This can happen only with enough light penetration for photosynthesis, usually down to 40 m, so it mainly happens in the littoral/coastal ecosystem.

Seagrasses defined the rooted flowering plants that have to adjust to life in the marine environment. They are also primary producers, forming extensive meadows, valuable to the marine ecosystem, critical to many fish species, invertebrates and birds. Seagrass beds play an essential role in sheltering the coast from wave action and erosion. In the Eastern Mediterranean and particularly in Greece, four species of seagrasses have been identified: *Posidonia oceanica, Cymodosea nodosa, Zostera noltii* and *Halophila stipulacea*. Especially, Posidonia seagrass (named after the Greek sea god Poseidon) is of paramount importance to the eastern Mediterranean and Greek seas.

Invertebrates are called organisms without a spine. It is considered the most diverse taxonomic group on the planet. The Mediterranean Sea alone recorded approximately 6,500 species of marine invertebrates such as squid, sea urchins, sponges, jellyfish, and starfish.

The last group with more than 600 species is made up of fish. In the Mediterranean, there are 86 species that are endemic to the area. They come in varying sizes, shapes, and colors due to the unique adaptations of each species, allowing them to thrive in their habitat in the marine ecosystem.

The marine ecosystem habitats from biodiversity importance and the needs of this deliverable are divided into three major categories. These habitats are the *Posidonia oceanica*, the maerl and the Coralligenous habitats.

Two precious marine habitats are found in the Greek seas: *Posidonia oceanica* seagrass meadows and deep-water coralligenous reefs. These habitats harbour significant levels of biodiversity, including several commercially important fish species. They additionally present a broad array of ecosystem services, such as fish nursery grounds, carbon sequestration and protection of the coast against erosion.

III.1.1. Posidonia oceanica meadows Habitat

Posidonia oceanica is a species of marine phanerogams' endemic to the Mediterranean Sea. It is a higher plant - marine angiosperm, although we often falsely call it "algae". It forms enormous underwater meadows that are an essential part of the ecosystem. Its fruit is freely dispersed, floats, and is known in Italy as "the olive of the sea" (l'oliva di mare).

It is a species with extensive distribution in the Mediterranean and on the coasts of Greece. The area of the Mediterranean covered by its meadows is 37,000 sq.km., *i.e.*, about 1-2% of its total area. It belongs to the soft substrate societies with a maximum depth of distribution of 50 meters. The genus Posidonia according to the classification in 5 flora elements of taxa, belongs to the Cosmopolitan species, as it grows in all latitudes and longitudes.

More than 300 species of plants and more than 1,000 species of marine animals live in the meadows of *Posidonia*, including many fish of fishing importance. These are habitats that play a fundamental role in maintaining the health and productivity of marine ecosystems (Fig. 3). First, they are breeding grounds, operating as nurseries for many species. Local fisheries are affected when Poseidon meadows disappear. Second, they prevent coastal erosion through their rhizomes and leaves. With the deforestation of the sea meadows, many beaches are threatened with shrinkage or even disappearance. Third, underwater forests trap carbon from the atmosphere.

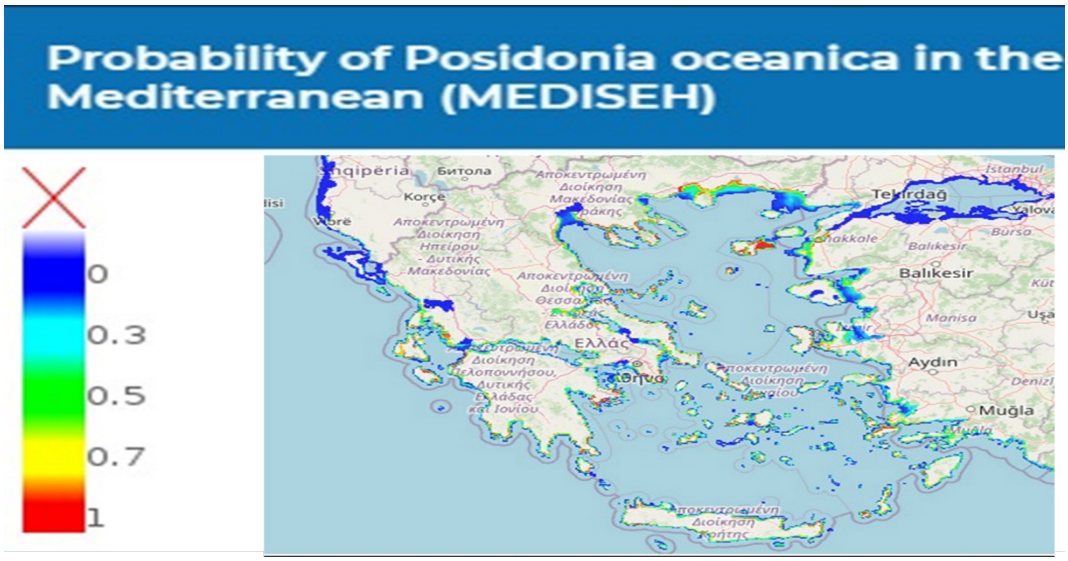

Figure 3. *Posidonia oceanica* Habitats in Greece (emodnet.ec.europa.eu)

III.1.2. Maerl (rhodolith) beds Habitat

In the Mediterranean Sea, maerl - rhodolith beds are located from 9 to 150 m of water depth, with an average depth of about 55 m in both sub-basins. Most maerl-rhodolith beds lay within the depth span between 30 and 75 m, while those reaching deeper than 75 m are only around 18 % of the total, and those shallower than about 25 m are rare (Fig. 4). Water motion from bottom currents, waves, and tides is needed to hold rhodoliths unburied within mesotrophic to oligotrophic water conditions. Maerl-Rhodolith beds are generally small (<0.01 km^2) and multi-species, revealing a mixture of growth-form and much higher coral biodiversity than Atlantic beds. They are vulnerable to environmental disturbance by fishing gears and smothering and water contamination by organic enrichment and sewage.

The existing means of legal protection appear unfavourable. These are based on scientific research principally derived from northern Europe, where specific and diverse environmental settings, species composition, depth pattern, and anthropogenic pressures occur. The protection of a particular habitat type cannot be effectively achieved without access to geospatial and compositional data. An expanded research effort is needed to enhance taxonomic inventories, habitat mapping, and monitoring activities on a basin scale.

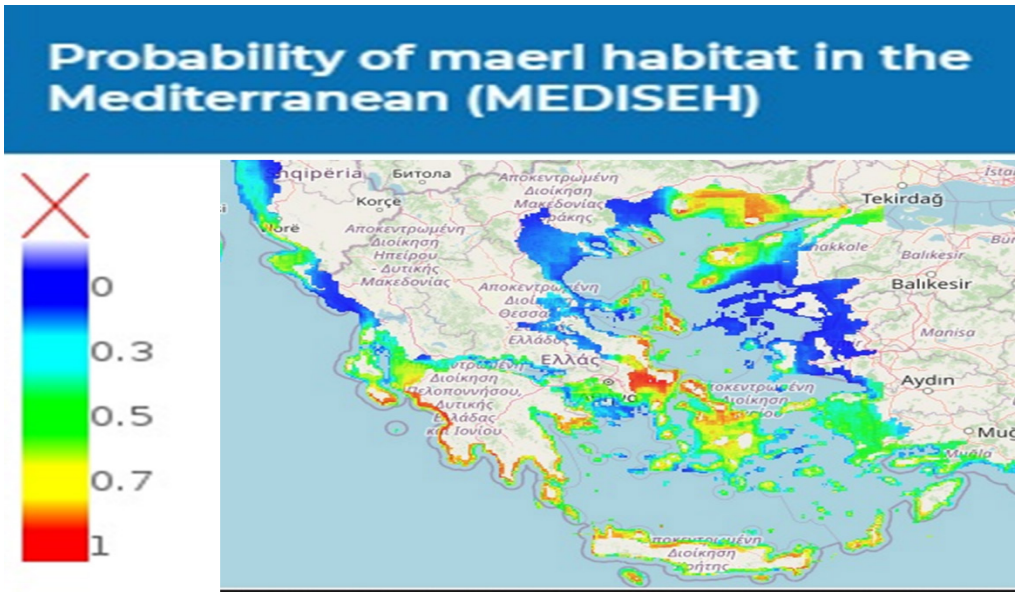

Figure 4. Maerl Habitats in Greece (emodnet-seabed habitats EU)

III.1.3. Coralligenous biocenosis Habitat

The word coralligenous ("coralligène" in French) was firstly introduced by (Marion, 1883) to describe the hard bottoms of the Mediterannean, which range between 30 and 70 meters depth and located between seagrass meadows of *Posidonia oceanica* and coastal muddy bottoms. "Coralligène" means "producer of coral" and is related to the abundance of red coral (*Corallium rubrum*) in a specific type of bottoms.

Coralligenous formations are referred to as biogenic structures typically found in the Mediterranean Sea. Their complex, multi-layered species assemblies are composed of permanent, long-lived organisms, particularly vulnerable to natural or human-induced changes. Notwithstanding their high biological role and preservation value, few studies have approached the assemblages outside the NW Mediterranean. The coralligenous in the North Aegean Sea (North-Eastern Mediterranean) and more generally of Greece (Fig. 5), focusing specifically on the upper bathymetric level of groups dominated by the yellow gorgonian *Eunicella cavolini*. The quantity and percent cover of microbenthic species were studied at depths of 18 to 35 m, using a photo quadrat method. A total of 99 benthic taxa were recognized, out of which 89 perennial ones were used to examine spatial patterns in association structure, form, and biodiversity. An average number of 47 perennial taxa were registered per site, with encrusting coralline algae and sponges being the dominant organizations in percent cover and species number, respectively. Beyond the studied localities, structural complexity and community composition were overall comparable. Still, assemblages presented unique differences at the level of sites highlighting the role of local abiotic and anthropogenic factors in shaping the coralligenous. Compared to the rest of the Mediterranean Sea, groups hosted a comparable number of taxa. Nonetheless, the number and percent cover of erect

bryozoans were frequently low, while, apart from *E. cavolini*, other upright anthozoan species were absent (Sini *et al.* 2019).

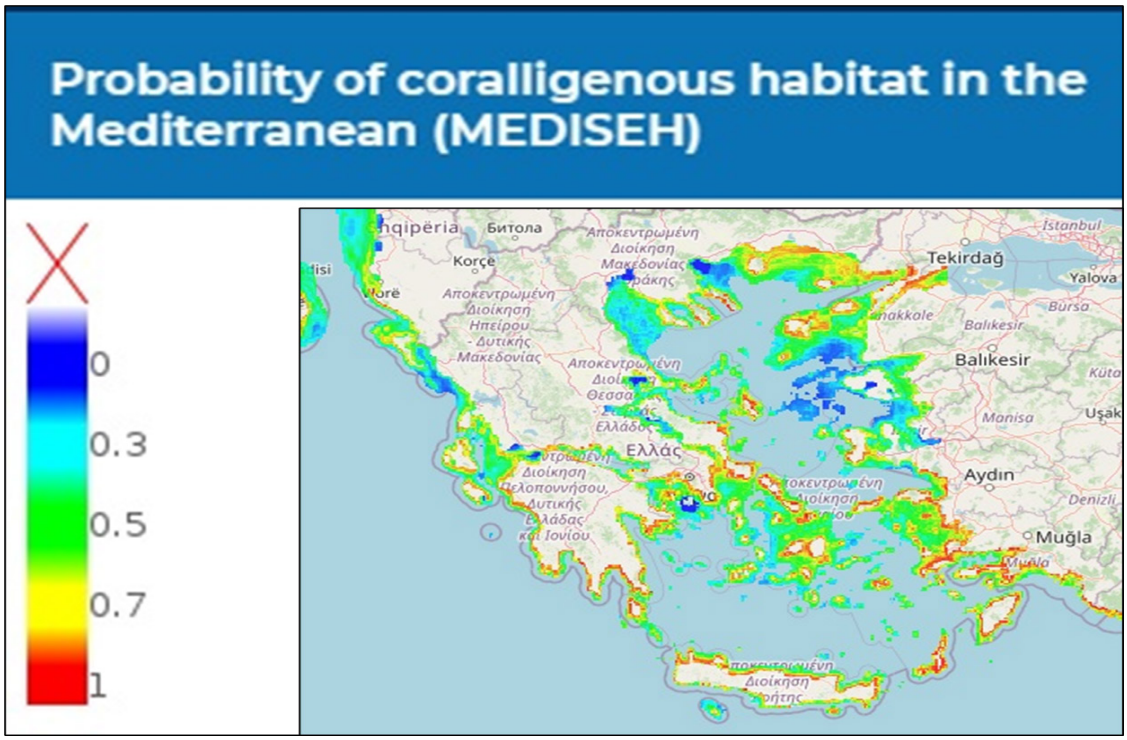

Figure 5. Coralligenous Habitats in Greece (emodnet-seabed habitats EU)

III.1.4. Other Habitats – Wetlands (Deltas, Marshes, Lagoons, Estuaries, etc.)

Wetlands are among our planet's essential resources from a biodiversity and productivity perspective. Wetlands designated as areas covered by marsh, fen, peatland, or water, whether physical or artificial, permanent, or temporary, with water that is static or flowing, fresh, brackish or salt, including fields of marine waters, the depth of which the mean tide does not exceed six meters. A primary feature of the transitional zone within permanently flooded and strictly terrestrial areas is hydromorphic soils and hydrophytic plants. In 2000, the first record of Greek wetlands by the Greek Biotope Wetland Centre reported 411 wetlands, most of which are in Northern Greece (39). Recently, WWF Greece has developed a new record of wetlands on Greek islands by fieldwork (Katsadorakis and Paragamian, 2007). The organization recorded 803 natural and artificial wetlands with areas longer than 0.1 ha on 75 islands (194 on Crete, 100 on the eight Ionian Islands, and 511 on the 64 Aegean Islands). Most of these wetlands (80%) cover between 0.1 and 8 ha, which signifies their vulnerability to deterioration. Ten of these wetlands are designated as Wetlands of International Importance according to the 1971 Ramsar Convention on Wetlands. Seven of these wetlands are included in the Montreux Record, which highlights localities with unfavorable changes in ecological character, and which therefore require greater conservation awareness.

Notwithstanding the services that wetlands provide, wetlands globally continue to be subject to many impacts from human activities happening either in the wetlands or in the more extensive watershed. Human actions frequently harm these ecosystems. Such activities involve pollution (*e.g.*, from surrounding factories and intense agricultural development), loss of wetland cover (*e.g.*, drainage for human health, the growth, and expansion of fields or urban areas into agricultural land, water removal for irrigation or human consumption, changes in vegetation types, and the modification of wildlife). Recently, research has shown that the diversity of habitats in Greek protected wetland areas is linked with climate (Drakou *et al.* 2011). The list of pressures on wetlands has been appended to embrace climate change. According to the first Greek wetland record, 42% of wetlands are subject to pollution from agriculture, while 20% are affected by drainage and wetland transformation into agriculture fields. Irrigation foundations influence 14% of wetlands, while water extraction for irrigation affects 15% of wetlands. Approximately 36% of wetlands receive urban wastewater, while 28% receive wastewater from industries. Conversion into urban areas and tourism infrastructures affect 26% and 13% of wetlands, respectively. For island wetlands, the situations are likely to be more disadvantageous because these wetlands tend to be small and positioned near coastal tourist areas. Land restoration is a common occurrence in these areas and poses a significant menace to such vulnerable ecosystems. According to the WWF Greece inventory, 63% of island wetlands have been changed by land restoration, 55% of wetlands have shrunk due to urban growth, 57% of wetlands have been fragmented by road building enlargement of agricultural fields endangers 45% of wetlands. More than 35% of wetlands receive wastewater from cities and communities. Based on the island's wetlands inventory data, 50% of the wetland areas have been significantly disturbed.

In comparison, 43 sites (about 5%) have significantly declined to the point of losing their ability to function. Even though our knowledge about island wetlands is comprehensive and could be considered marginally sufficient, our understanding of continental wetlands remains limited to the significant wetlands, leaving a vast information chasm. Because of the status of our knowledge, and in combination with changes in human activities and the climate affecting hydrological conditions, it is considered necessary to update and improve the geographic datasets about Greek wetlands to better plan their preservation.

Greek wetlands of the Greek Biotope/Wetland Centre (EKBY), 411 wetlands have been recorded in Greece, most of them (2/3) located in northern Greece and 109 of which are on the islands of the Aegean Sea, the Ionian Sea and Crete. The ten most valuable wetlands of Greece have been nominated as Wetlands of International Importance under the Ramsar Convention. They are included in the areas of responsibility of the management bodies established under Law 3044/2002.

Due to their importance, lagoons constitute priority habitats of European concern (Directive 92/43/EEC). According to the 2nd national report on Directive 92/43/EEC implementation, their conservation status in Greece is poor. To ensure their adequate

protection, Greece shall have to appoint Special Areas of Conservation. Moreover, the country's responsibilities under Directive 2000/60/EC mandated that by 2015, the water quality in the lagoons had to be in "good" status. The main lagoon network in Greece is presented in Figure 13, in Annex I.

A recent record of wetlands on the Aegean islands by WWF-Greece (Katsadorakis and Paragamian, 2007) classified 352 wetlands in 51 Aegean islands and islets (except Crete). The record of the wetlands of Crete was started in spring 2008 and, during the first phase, identified 228 wetlands.

Out of the 352 island wetlands, 257 are natural and 65 artificial, while 21 are less than 0.1 ha and nine are devastated. The natural wetlands of the Aegean islands add up to a total area of ca 40 km^2, of which ca 30 km^2 are found on three islands (Lesvos, Limnos, and Evia). The majority are coastal, groundwater-fed and of fluctuating salinity. They essentially combine small estuaries of seasonal streams/rivers with or without coastal marshes and open water areas. More than half of them is less than 1 ha, while only five are larger than 3 km^2. Notwithstanding their minimal size, opposed to the extensive continental wetlands, the Aegean island wetlands are of valuable importance for the preservation of biodiversity: they host a variety of endemic taxa (*e.g.*, fish: *Ladigesocypris ghigii* [endemic to Rhodes], *Oxynoemacheilus theophilii* [endemic to Lesvos]; amphibians: *Rana cerigensis* [endemic to Karpathos]), unique habitat types of utmost importance for the animal life in the archipelago and they form indispensable stepping-stones for migrating birds as well as a refuge in cases of heavy cold spells.

Table 1. Wetland Types in Greece and the number of sites

Wetland type	Number of sites
Deltas	12
Marshes	75
Lakes	56
Lagoons	60
Springs	17
Estuaries	42
Rivers	91
Reservoirs	25

Human activities conducted in wetlands and their drainage basins do influence the wetlands. Nowadays, wetlands in Greece are primarily endangered by point and non-point source pollution (from agriculture, industry, housing facilities, *etc.*), the expansion of crops and housing facilities at the expense of wetlands, over pumping, and clearing of natural vegetation. Over the last few decades, new causes of degradation have occurred, such as mass tourism, holiday houses, seaside airports, *etc.* According to the above inventory of the Greek Biotope/Wetland Centre, 42% of all wetlands are exposed to non-point source pollution from farming activities, whereas 20% are endangered by installing or developing agricultural holdings. Irrigation works threaten 14% of wetlands, whereas over pumping threatens 15%. A rate of 36% of wetlands collects waste from housing facilities and 28% holds waste from craft industries and various processing industries. Eventually, the establishment and extension of housing and tourism facilities cause degradation to 26 and 13% of wetlands, respectively.

III.2. Threatened species and their impacts on coastal ecosystems

The Mediterranean Sea covers 0.7% of the world's ocean area, but it is considered one of the significant marine and coastal biodiversity reservoirs despite the low rate. This little semi-closed sea with 28% of endemic species and 7.5% of the world's marine fauna, and 18% of its marine flora, has many islands and rich underwater beds and significant wintering, reproduction, and migration areas for several species.

However, on the Mediterranean Sea coasts, around 150 million residents live and practice their activities and every year, it is estimated that more than 200 million tourists arrive in this area. As a result, coasts are under continuous and growing human pressure, and the consequences were uncontrollable for many decades. The main problems were and to a degree remain the unrestraint and rigorous urbanization, the overexploitation of natural resources, the proliferation of alien species, increasing needs for maritime transportation of goods and humans, and pollution of the marine ecosystem have directly led to the degradation of biodiversity within it, where there is a depletion of the most sensitive endemic species and, first of all, the threat to important and unique coastal habitats, some of which constitute extraordinary sites and are characterized from the point of view of biodiversity as hot spots.

During the Messinian crises (5 to 6 million years ago), the Mediterranean Sea dried up with the disappearance of most of its fauna and flora communities. Following this event, the communities of the Mediterranean had to be re-established from the Atlantic Ocean. Consequently, Atlantic species entering the Mediterranean evolved to give rise to several species and varieties. Endemic species are therefore the descendants of certain immigrant species. This event considered as recent endemism or neo-endemism manifested at a specific level. The percentage of endemism is very high in the Mediterranean than in other regions of the world (Cuttelod *et al.* 2008; Fredj and Maurin, 1987).

III.2.1. Flora in Greece

The floristic abundance in Greece is great, as it includes more than 6 500 native plants, while endemic taxa (species and infraspecific taxa) reach the number of 1 500. This vast biodiversity, the highest in the European Union (considering the small area of Greece), should be connected to various bioclimates and geologies and to an adventurous paleogeology. As part of this abundance, the Greek coastal and terrestrial ecosystem offers a unique experience to everyone to travel the country and explore its unique characteristics and take advantage of its natural and fragile wealth (Fig. 7).

The most current comprehensive catalogue of Greek endemic plants listed 752 species (Thomback and Jenkins, 1982), a number later corrected to 742 (IUCN, 1994), which has since been quoted in the bibliography (Tan and Strid, 1997). Except that, there is a recent endemic flora (Tan and Iatrou, 2001) of the Peloponnese (Peloponnisos) and a report of the disparately larger figure of a total of 1,275 endemic taxa in Greece.

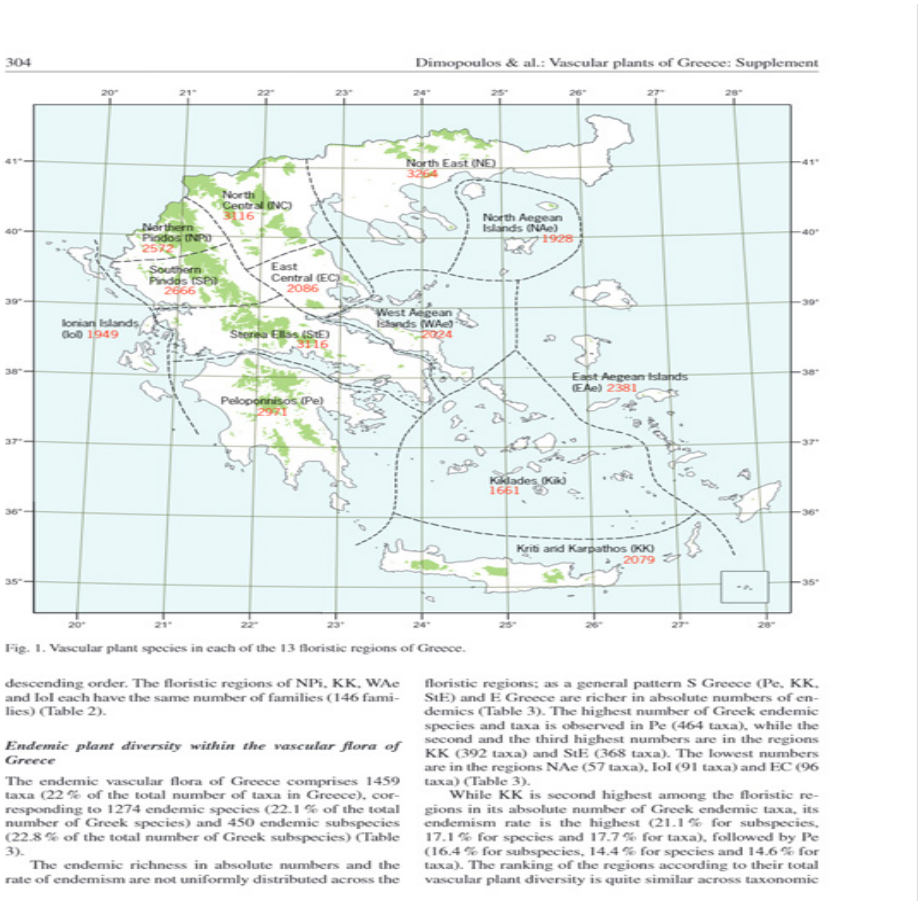

Figure 6. Vascular plant species in each of the 13 floristic regions of Greece (Dimoudi *et al.* 2003)

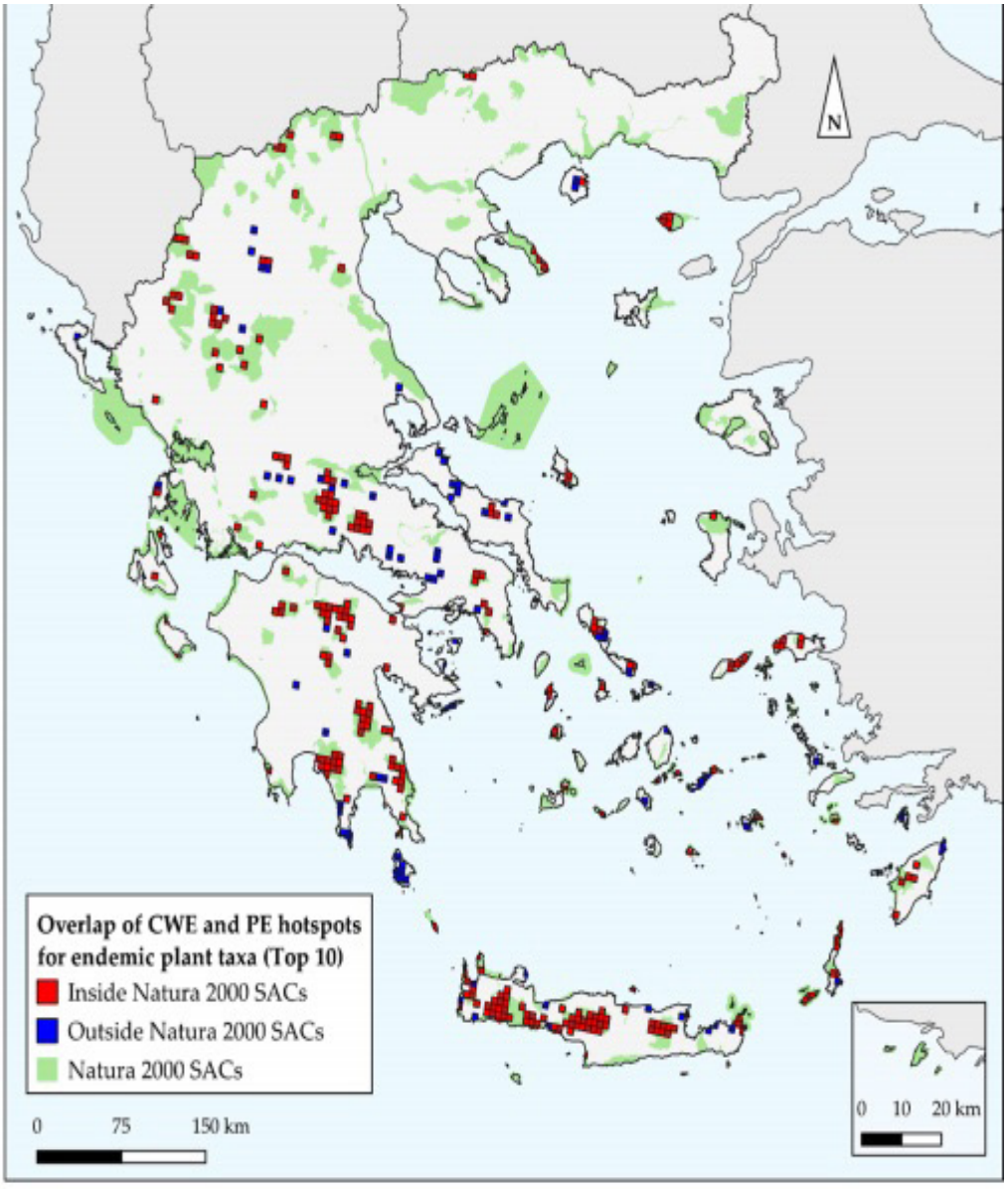

Figure 7. Red colouring indicates cells identified as Priority Hotspots inside the Natura 2000 SACs. Blue colouring indicates cells identified as Priority Hotspots outside the Natura 2000 SACs. Green polygons depict the Natura 2000 SACs in Greece (Kougioumoutzis *et al.* 2021)

III.2.2. Fauna in Greece

A principal specialty of Greek fauna is the high level of endemicity and the geographic differentiation of most groups of animal species. The hotspot of endemicity in Greece, for most animal species groups, located in Crete, followed by the Cyclades and the mountains of continental Greece. However, groups of species have more excellent endemic rates in other regions, like the Peloponnese and Ionian islands. It should be

emphasized that cave formations are essential features for endemics, and until now only a minor proportion of caves has been studied in Greece. Yet our information gaps on faunal patterns are huge, and only a few groups of invertebrates and vertebrates are sufficiently covered. For vertebrates, the entire quantity of species in Greece and their classification according to their preservation status are presented in Table 2. Overall, nearly 15% of vertebrate species are considered threatened (*i.e.*, classified as critically endangered, endangered, or vulnerable according to the IUCN criteria). There is a considerable shortage of data for some groups of species (like fishes and mammals), so the estimations are somewhat doubtful.

Animal diversity in Greece is preserved under many laws, the most important of which is the European Habitats Directive. In 2007, 182 species of community interest (following the annexes of Directive 92/43/EEC) were registered in Greece. Out of these, 14% were classified as being of favorable conservation status, 14% as unfavorable–inadequate 7% as unfavorable– bad and for 65%, the status has failed to be determined. Bird diversity is principally protected following the provisions of the Birds Directive, which includes 286 species observed in Greece (147 resident species and 139 migratory ones). The avifauna in Greece consists of 37 species considered globally threatened, mainly from wetland birds and birds of prey (Maragou and Legakis, 2009).

Invertebrate biodiversity in Greece is also quite vibrant, with around 27,000 species reported, including 4,000 Greek endemics. It should be emphasized that, for most groups of invertebrates, our knowledge is limited (Table 4). Thus, it is estimated that there are still thousands of species to be recorded shows the total number of invertebrate and endemic species of the most studied invertebrate groups. Table 3 presents the data for the groups of species that have been assessed according to IUCN criteria for the conservation status of invertebrate species.

Table 2. Total number of threatened marine and aquatic vertebrate species in Greece according to IUCN conservation status34 (Maragou and Legakis, 2009)

ΚΑΤΗΓΟΡΙΑ	Regionally extinct (RE)	Critically endangered (CR)	Endangered (EN)	Vulnerable (VU)	Near Threatened (NT)	Least Concern (LC)	Data Deficient (DD)	Not Evaluated (NE)	Total number of species in Greece	% of species threatened (CR,EN,VU) out of the total number of species
Marine fishes	0	5	4	5	0	0	0	453	476	2,9
Freshwater fishes	5	14	12	23	3	60	15	0	154	31,8
Amphibians	0	1	2	3	3	13	0	0	22	27,3
Reptiles	0	2	4	6	6	46	0	0	64	18,8
Birds	1	14	17	31	16	26	17	227	442	14,0
Mammals	0	3	12	13	11	10	20	69	115	24,3
TOTAL	**6**	**39**	**51**	**81**	**41**	**159**	**45**	**718**	**1273**	**13,4**

Table 3. Total number of threatened invertebrate species in Greece according to IUCN conservation status (Ministry of Environment Energy & Climate Change, 2014)

ΚΑΤΗΓΟΡΙΑ	Regionally extinct (RE)	Critically endangered (CR)	Endangered (EN)	Vulnerable (VU)	Near Threatened (NT)
Porifera				10	
Cnidaria			2	28	
Polychaete			1	3	
Polyplacophora				1	
Bivalvia			1	4	
Gastropoda (marine)				10	
Gastropoda (terrestrial)	70	28	63		211
Cephalopods				1	
Aranea	20	9	4		
Amphipoda				3	
Isopoda	41	2	4		
Decapoda		1		11	
Chilopoda	3	3			
Odonata	2		5		
Orthoptera	1		1		
Lepidoptera	4	19	16		
Coleoptera		2	3		
Echinodermata			1	4	
Ascidiacea				1	
TOTAL	**141**	**64**	**99**	**76**	**211**

Table 4. Species richness by taxa and by region of the Mediterranean Sea (Coll *et al.* 2010)

	W Med[1]	E Med[2]	NW Med	Alboran Sea	SW Med	Adriatic Sea	Central Med	Ionian Sea	Aegean Sea	Tunisian Pl.[3]/Gulf of Sidra	Levantine Basin[10]	Reference[11]
Ceramiales (Rhodophyta)	248					198	211		193			
Phaeophyceae			161		119[4]	160	183[5]	122[6]			74	[16]
Porifera			432	181	123	230		181	200	90	94	
Anthozoa	151					100		58	90		38	
Gastropoda	1148					462	582		622		83	[66]
Cephalopoda	61	55				45						[435]
Polychaeta	946	877										
Harpacticoid copepoda	254								96			
Cumacea	85	74	78	43	42	13	50[5]	28	43	4	48	
Mysidacea	90	55	62	9	2	34	64[5]	7	5	30		
Euphausiacea	13					12	13		12		11	[67]
Isopoda	149					47	26		74		34	[66]
Cirripedia	34					17	17		17		13	[66]
Amphipoda	421					242	160		260		144	[66]
Decapoda [1]	316					228	205		252		59	[66]
Decapoda [2]						293[7]			260		230	
Echinodermata	144[8]					101	98[9]		107		73	
Sipuncula			45	19	15	36	36			16		
Ascidiacea	193	167										

The results for vertebrate species indicate that there was a decreasing inclination from the northwest to the southeast. At the same time, the neighboring sea of Sicily had the most extraordinary wealth, followed by other coastal and plateau areas in the northwest (Figs. 8 A–B). The distribution of elasmobranch species was not homogeneous either, conferring a greater concentration of species in the west (Fig. 8 C). The endemic richness gradient of fish species was more declared with latitude, the north side exhibiting a more incredible richness, and the Adriatic appearing as a hot spot of endemism with 45 species per cell (Fig. 8 D). Spatial patterns also confirmed how most Mediterranean coastal waters had been colonized by exotic species (Fig. 8 E).

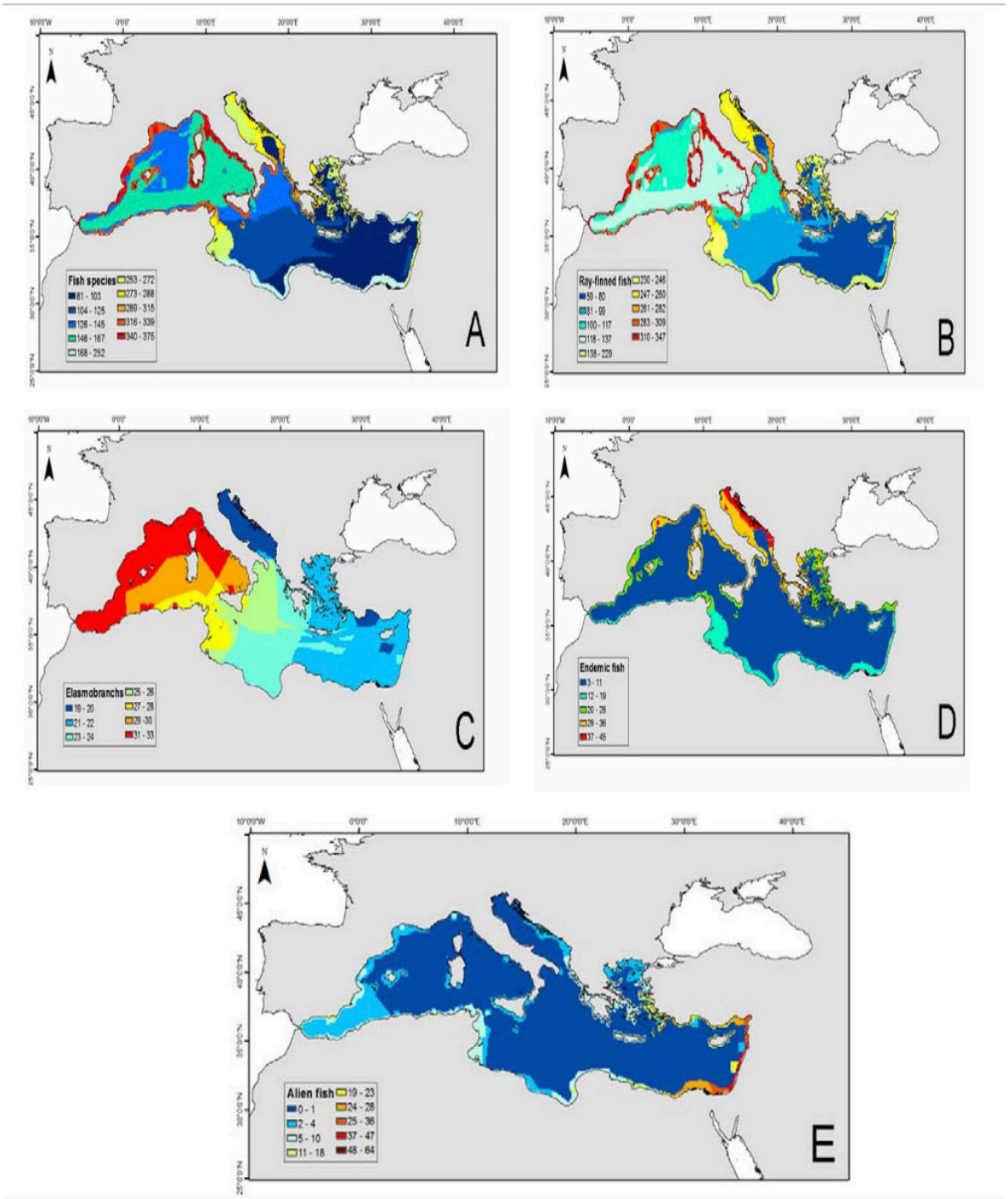

Figure 8. Spatial patterns of fish species richness in the Mediterranean Sea based on superimposed expert-drawn maps (Coll *et al. 2010*). (A) All fish species (n = 625), (B) ray-finned fish species (n = 545), (C) elasmobranchs (n = 80), (D) endemic fish species (n = 79), (E) alien fish species (n = 127). The colors express the occurrence of species from blue (little or no occurrence) to red (highest occurrence). The size of the cell is 0.160.1 degree (Coll *et al*. 2010).

The Western Mediterranean and the Aegean seas (Fig. 9 A) group marine mammals. Eight marine mammals were found in the western part of the basin's total of nine residents. This distribution pattern was also recorded for the migrating marine mammals (Fig. 9 B). The central Mediterranean and Aegean seas observed two of the three resident sea turtles (loggerhead, green, and leatherback turtles). In comparison, the two visiting turtles were absent on the east side (Fig. 9 C). There were fewer seabird colonies; and seabird density was lower in the southeast than in the northwest (Fig. 9 D).

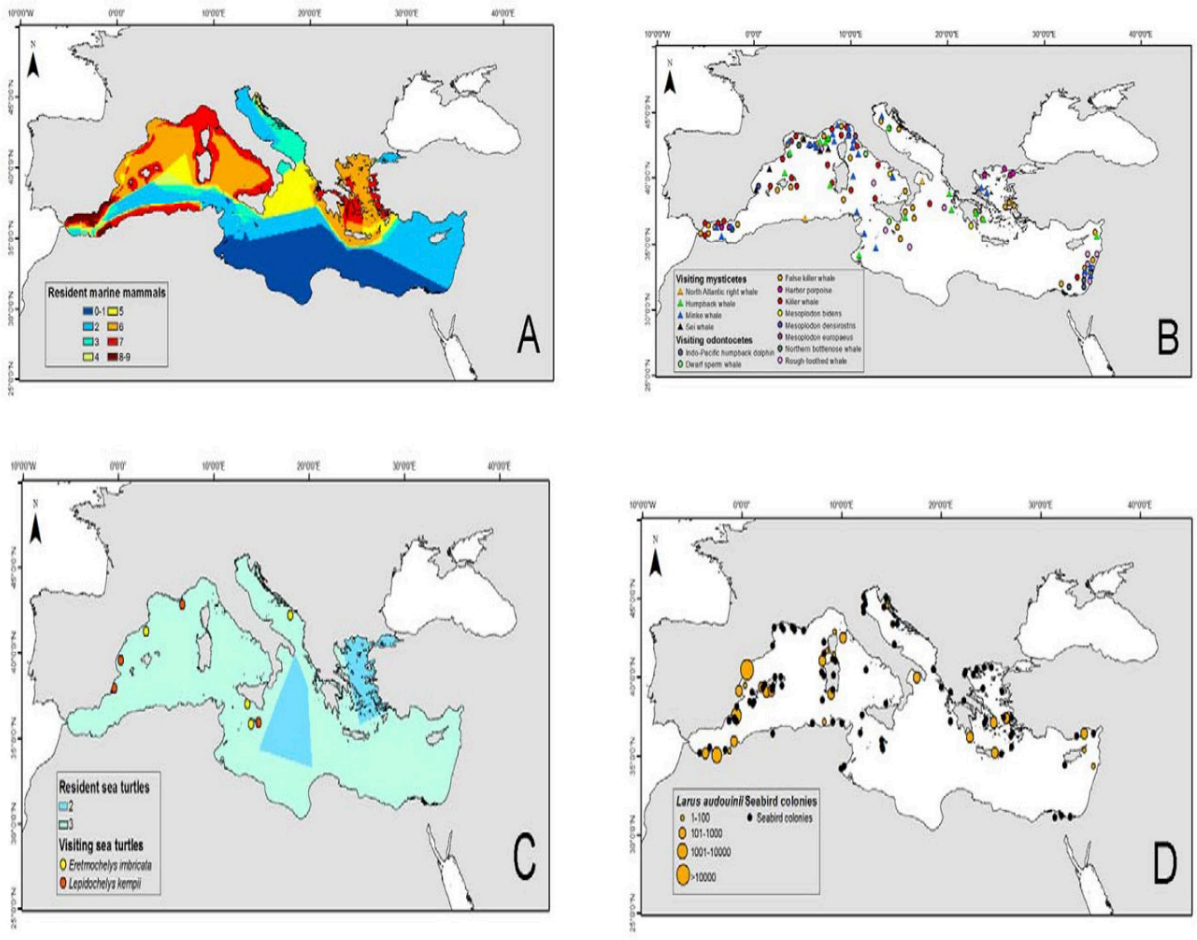

Figure 9. Spatial patterns of vertebrate species richness in the Mediterranean Sea based on superimposed expert-drawn maps (excluding fish species) (Coll *et al.* 2010).

(A) resident marine mammals (n = 9), (B) nonresident marine mammals (n = 14), (C) resident sea turtles (n = 3), as well as sighting records (dots) of the two visiting sea turtles. Colors express species occurrence from blue (little or no occurrence) to red (highest occurrence). (D) Seabird colonies (the yellow dots show the distribution and population density of colonies in breeding pairs (bp) of Audouin's gull: Some dots represent the epicenter of several smaller colonies in archipelagos) (Coll *et al.* 2010).

III.3. Alien Species

Invasive species are defined as alien species with the capacity to increase in regions away from their normal distribution area, if they are disbanded in the new locations. Globally, invasive alien species are recognized as significant threats to biodiversity in terrestrial, freshwater, and marine ecosystems. In Greece, invasive/alien species causing problems for indigenous species and biodiversity have already been recorded. This fact makes the approval of preventive measures a crucial priority, starting with the studies and detection of invasive alien species already present in the country and the monitoring of their entry into the Greek seas, to take the necessary measures to stop the spread of the invasion of these species. Their invasion begins with an intentional or accidental introduction and then the alien species escape in the terrestrial, freshwater, or marine environments. Accordingly, it is needed to raise public awareness about the threat presented by alien species intrusions. Dealing with invasive species' negative impacts on biodiversity requires early detection, continuous monitoring, steps to limit their consequences to biodiversity, and efficient implementation of the CITES Convention. The first step towards an action plan depends on the classification and mapping of alien species invasions in Greece.

The eastern Mediterranean (Fig. 8 E) is particularly vulnerable to biological invasions because of its crossroads position between the Ponto-Caspian and the Indian Sea/Red Sea regions, the maritime traffic Dardanelles, Gibraltar and Suez, and the existence of large and numerous fish and shellfish farms. As a result, Greek waters can function as a gateway, presenting an excellent distribution in Greek waters (Fig. 10) for the dispersal of marine alien species, either from the Levantine towards the Adriatic and the West, or from the Black Sea towards the eastern Mediterranean. The flow of intrusion of alien marine species in the Mediterranean Sea is rising (Zenetos, 2011). The extent of alien species initially established in the Levantine, to separate biogeographic regions such as the Aegean. Moreover, the scientific community has increased its attempts to examine alien intrusions in coastal ecosystems as the endemic biodiversity is in danger.

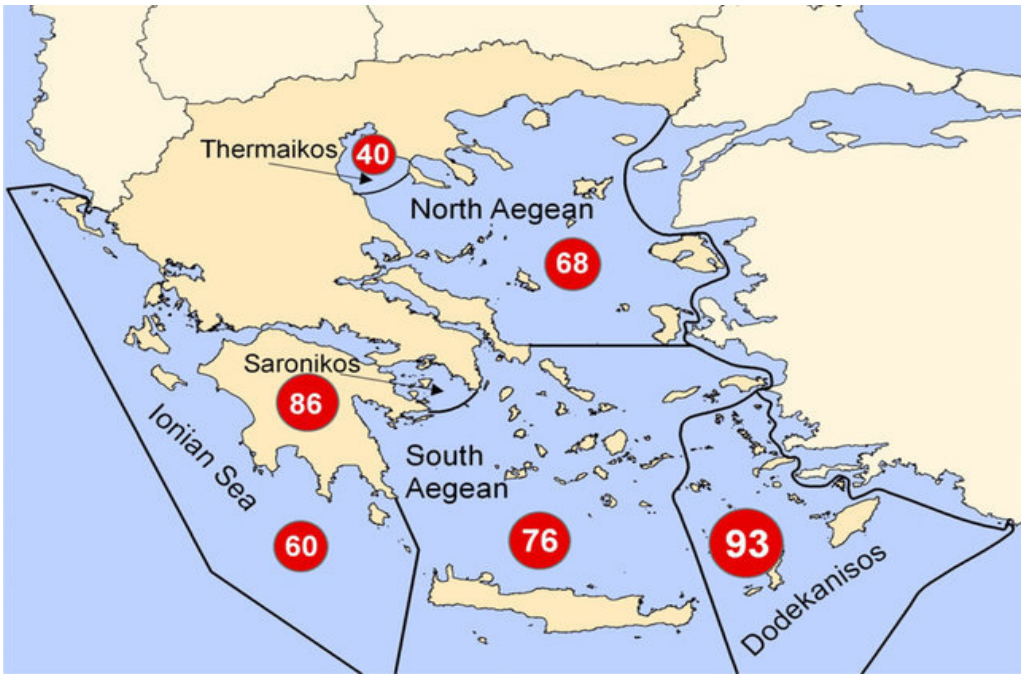

Figure 10. Pattern of alien species distribution in Greek seas, the figures represent the number of species (Zenetos *et al.* 2011)

In 2010, ten species previously known as Occasional and Questionable immigrants had been identified as viable populations and had spread to several Greek coasts. Of the 237 alien species recorded in Greek waters, 127 are established; 59 are casual records; 20 are cryptogenic and 31 are questionable records. Most alien species belong to Mollusca (47 species: 19.8%), followed by fish (41 species: 17.3%), Polychaeta (38 species: 16.0%), macroalgae (33 species: 13.9%), and Crustacea (31 species: 13.1%). Most newly introduced and recorded species come from tropical and subtropical areas of the Pacific, Indian or Atlantic oceans. The increased rate of introductions of warm-water species proves previous findings linking the rate of introduction in the eastern Mediterranean to climate change. Although many newly listed species are Lessepsian immigrants spreading across the Aegean Sea, the role of shipping is gaining importance as a vector for the transfer of alien species into the Aegean Sea (Fig. 11).

Some of the invasive species (www.naturagraeca.com) that cause problems and upset the balance of marine and coastal ecosystems with a negative effect on tourism are:

Plants: The Silverleaf Nightshade (*Solanum eleagnifolium*). Descend from America, and the silverleaf nightshade has covered all over maquis habitats. A remarkably adaptive plant -one centimetre of the root can give a complete plant, threatens the specific type of Mediterranean ecosystems, thriving where there should be thyme, oregano, and other indigenous shrubs. It is already found in most parts of southern Greece, especially in islands, without any systematic attempt to exterminate it.

The Tree of Heaven (*Ailanthus altissima*). Native to China, this remarkably adaptive tree has been widely used as an ornamental plant on roadsides and in cities. It can withstand frost and dehydration, so it is no chance to see it appearing in many of our forests next to firs, plane trees, lindens, ashes, willows, *etc.*, occupying their space.

Sea Fish: The Silver-cheeked Toadfish (*Lagocephalus sceleratus*) is a dangerous fish, and a migrant from the Suez Canal. Some organs of the species (skin and entrails) are very toxic and can cause death if eaten. Incidents of fatal poisoning have been reported in Israel and Lebanon. At the same time, it is a fearless fish that strikes when threatened. Its quantities are constantly increasing in southern seas, and it seems that with the temperature rise, it will not be long before it expands further north.

The Dusky Spinefoot (*Siganus luridus*). This expansive fish derives its Greek name from the German language (from the Nazis), as it appeared here at WW2. t has since spread to all Southern Greece, creating enormous difficulties for coastal fisherman. The daily migration of herds from deep to shallow waters traps thousands of them in the nets. Fishers often dump their nets because the first dorsal ray of the Dusky Spinefoot carries a toxin that creates swelling and pain, so it is nearly impossible to dislodge thousands of them from a net.

Crabs: Sally Lightfoot (*Percnon gibbesi*) is a crab that is transferred to Greece clinging to large ships. It expands rapidly across Greece seabed, stripping the rocks of every organism that can be eaten. A particularly fast crab, with a cryptic behaviour, that makes it very difficult for predators to catch it.

Nudibranchs: The Spotted Sea Hare (*Aplysia dactylomela*). This large nudibranch has managed to expand to all temperate and tropical waters of the planet. It belongs to the same genus as three other native species of Greek seas. However, its defensive behaviour, which involves the secretion of purple ink, makes it resistant to any native predator, thus gaining a survival advantage over our own “sea hares”. Now it is found in greater numbers and in more of Greece’s seabed.

Corals: *Oculina patagonica*. This coral first appeared in the Mediterranean in 1966, coming from the coasts of North America. Although it spreads gradually, it is now encountered more and more often by scuba divers. One of its characteristics is that it is applied next to the rigid substrate. Under the right conditions, it can give colonies up to one meter, displacing any other animal or algae living attached to the rocks.

Algae: *Caulerpa racemosa*. One of the most famous and old cases of invasion has so far destroyed vast parts of our seabed. Caulerpa comes from Australia and has escaped to the Mediterranean from the Monaco Institute of Oceanography laboratories. It is especially threatening for the *Posidonia oceanica* meadows as it creates a dense web that literally “drowns” any organism that tries to develop.

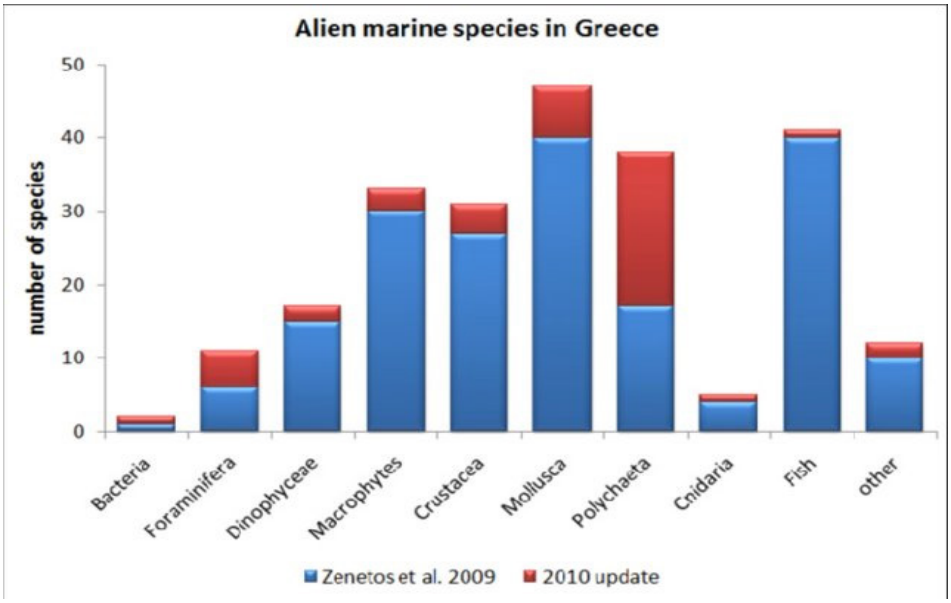

Figure 11. Breakdown of marine alien species in Greek Seas per taxonomic group (Zenetos *et al.* 2011)

IV. Relationship between habitat and endemic species and coastal tourism

IV.1. Introduction

The Mediterranean Sea is experiencing demographic and urban growth that continually increases year by year. It is characterized by large sea traffic and the extensive exploitation of its resources, which has appeared to be significantly threatened in the last few decades. The ecosystems of coastal areas and the rich and varied communities they shelter in small surface areas face the most severe threats. As a mosaic of land and water ecosystems, the coasts seem to be more fragile and desired. The Mediterranean coastal fringe is narrow and remains the favourite locus of numerous economic activities connected to tourism (water sports, boating) or the exploitation of natural resources (aquaculture, fishing). The coexistence of these different activities often singularly incompatible with each other and the source of many problems (pollution, coastal development, erosion, *etc.*), disrupts the balance of coastal ecosystems and seriously threatens their future preservation. In addition, to the ecological problem posed by these severe changes, especially regarding biodiversity, the extermination of many species is not without economic outcomes (affecting primary production, spawning or nursery grounds, *etc.*). In the face of such risks, it is imperative to set up a policy that would integrate sustainable development and environmental protection. It had emerged that the preservation of marine and coastal Mediterranean ecosystems would guarantee optimal management of live resources and conserves the overall quality of the marine environment.

Consequently, it will drive on maintaining tourist attraction in areas where these activities are an essential resource and a critical developmental asset. In this perspective, various protective legal measures were taken both within the framework of international agreements (Barcelona Convention for the Protection of the Mediterranean against Pollution, the Ramsar Convention for the Preservation of Wetlands, Habitat Directive for the Conservation of Natural Biotopes) and at national level (lists of protected species, setting up of Parks and Reserves, *etc.*). In 1985 these decisions were expressed in the Genoa Declaration, which protected endangered marine species and at least 50 new coastal marine localities.

The setting up of Specially Protected Areas (SPAs), started in the 1960s in France (setting up of the Port-Cros National Park in 1963), has considerably amplified in the Mediterranean region since that period, drove on by international conventions and supported by many organizations (UNEP/MAP, IUCN, European Community). Rather than protect a single species, these SPAs are commonly more effective in that they both protect a whole range of unique species as well as the biotope in which they live, and the ecosystems associated with them. In addition, because of their restricted geographic area and the limited financial means usually allocated to their management, monitoring is carried out more efficiently and more effectively in the SPAs than in the

case of any given species. SPAs have a generic terminology and may include national parks, reserves, or any other type of area with broadly varying states. The positive aspect of a protected area is practically always distinguished in that it has an impact on:

a) the preservation of the natural heritage (conservation of biodiversity, increase in biological production, protection of biocenoses[1] and notable landscapes),

b) public recognition (educational action, publication of educational documents), and

c) the development of scientific knowledge and research.

However, the economic impact is generally much debated. Indeed, the setting up of a protected area and associated legislation result in a range of restrictions and detentions those users of the marine environment may adversely perceive. The main constraints involved in setting up a SPA relate to sea professionals' activities (fishermen, fish farmers, planners, diving club officers) and tourists' (underwater hunters, divers, amateur fishermen, yachtsmen).

At the fishery level, without minimizing the impact of these constraints, it is becoming increasingly clear that the setting up of a SPA, when managed in close collaboration with sea users, may be an asset for regional economic growth. The establishment of an SPA closed to fishing makes it possible to reconstitute halieutic stocks and specially to export the surpluses of biological production towards the peripheral zones and thus to contribute to their reconstitution by "reserve effect." One of the consequences of this increase in production is the improvement of catches (for the same catch effort) and the growth of fishing activities (number of station bills, renewal of fishing gear, *etc.*). With ten years of hindsight, we see that the creation of the Port-Cros National Park has made it possible to reconstitute the stocks of groupers, which directly benefits all the neighbouring underwater areas. The Nueva Tabarca Marine Reserve setting in Spain has allowed the catch of two kinds of fish of high market value (the gilthead seabream and the dentex) to be increased outside the reserve. Anglers are not the only people who profit from the financial results of setting up a SPA. Tourism, a vital source of hard currency for many Mediterranean countries, includes Greece. Indeed, an essential one for isolated countries is another sector that profits from this natural environment protection. But the development of tourism also has drawbacks. If an attractive site is rated as a protected area, but without appropriate complementary management measures and means, this management failure may threaten biodiversity.

IV.1.1. The overall situation in Greece

With over 16,000 km. of shoreline, Greece has the most extended coastline of all Mediterranean countries. Because of the complex legislation and numerous institutions involved in environmental protection and preservation at the national level, there is no integrated network of coastal and marine protected areas. Eight coastal protected areas cover approximately 29,000 hectares but also include terrestrial regions. The

1 an association of different organisms forming a closely integrated community.

legal framework for safeguarding and preserving biodiversity and the coastal areas is sufficient, but its enforcement is challenged by various difficulties, slowing down the implementation.

The primary sources of impact listed in the National Report are:

- discharge of untreated wastewater from hotels, although the law requires that this be treated,
- mooring of sailing boats in Posidonia meadows the building of marinas and ports immediately next to lagoons, and more generally, the building of infrastructure - overcrowding of beaches - introduction of predators - unsupervised whale-watching in the middle of cetacean shoals. Various written documents also mention fishing with dynamite, still frequent near Sfakia (Crete) and on a smaller scale in Gavdos.

IV.2. Impacts on Habitats, Species and Protected Areas

There are two marine parks, the Alonissos Marine Park in the Northern Sporades (dating from 1992) and the Zakynthos Marine Park (dating from 2000). There are also many marines and coastal areas that are subjected to preservation measures (including 7 Ramsar sites):

- the Gulf of Amvrakikos (SPA) including very diversified environments: lagoons, stretches of fresh water, wetlands, salt marshes, shore/sylvan
- the delta of Aliamon, Axios, Loudias (SPA)
- the Evros delta (SPA)
- the Kotychi lagoons, cut off from the sea by a broadside system of dunes and wetland meadows
- the Messolonghi lagoons (SPA)
- the Nestos delta and lagoons.

Numerous tourists influences cause problems in these particular areas. Some examples, out of many, presented below, particularly for the monk seal:

- The building of a hotel was approved in the Ithaca Strait in the direct vicinity of caves frequented by the seals.
- In Kefalonia Island, sailing vessels entered the caves and caused a marked deterioration in the seal-watching ‘contacts.
- In the Kimolos and Polyaigos Islands and the Karpathos-Kasos-Kasonisia archipelago, the main threats are the constant degradation of habitats and the destruction of monk seals by fishermen.
- On the south-western coasts of Milos Island, the deterioration in the seal

population over current years could be attributed to the expansion in human pressure (very numerous visits during the summer) since the attraction of the sites makes them an area of great interest for tourism.

- The Pefkias-Xylokastron Nature Reserve: a littoral relic pine forest with great botanical diversity, overpopulated in the summer with notable risks of fire.
- The Alonissos Marine Park (Northern Sporades) includes eight islands and nearby marine areas with two areas protected because of their ecological importance, intended to protect the monk seal and other rare species of flora and fauna. The avifauna is extremely rich: Eleonora's falcon (3,000 pairs), Audouin's gull, Bonelli's eagle, Cory's shearwater, Desmarest's shag, plus a significant number of birds of prey: European sparrow hawk, common buzzard, peregrine falcon, northern hobby, Eurasian kestrel, *etc.* The fauna of marine mammals (not including the monk seal) is equally so, with the common dolphin, the striped dolphin, the long-finned pilot whale, the sperm whale, and the false and the killer whale. The marine fish fauna contains over a hundred species. The main threats come from the public's desire for monk seal watching, which gives rise to severe disturbance problems.
- The Vai Nature Reserve (Crete). This is a small reserve intended to protect a relic forest of *Phoenix theophrastii*. This is, with the fan palm, the only endemic European palm. The larger natural *Phoenix theophrastii* population is found on Vai beach, on the eastern coast of Crete. Some groups have also been discovered on the south-western coast of Turkey. In Vai, thousands of wild plants are protected by a dissuasive fence. The main threat comes from fires started by tourists, mainly campers, and from vehicles being driven about, preventing plant regeneration.
- The most crucial range in the Mediterranean is the number of loggerhead nests (about 700-1,000 per year) on the island of Zakynthos in Laganas Bay. There is also an outstanding presence of small cetaceans like the common dolphin and the bottlenose dolphin. The most severe threats are infrastructure building straight on the coast, the beaches, the dunes and sometimes the cliffs that may induce nesting sites degradation for sea turtles. The touristic recreational activities may disturb nesting activity of sea turtles and cause noise pollution to cetaceans. Marine debris generating from beach use is another concern for the survival of these populations that may ingest or be entangled in marine litter.

IV.3. Action taken

Many actions to preserve habitats and fauna and flora biodiversity are undertaken, particularly regarding protecting unique endangered mammals, like monk seal habitats. Some of these operations are mentioned below. The Greek state has for a long time developed a policy of creating protected areas. Two Marine Parks have been made,

Alonissos and Zakynthos, and many coastal protected regions such as the Evros delta, the Gulf of Amvrakikos, the Kotychi lagoons, the Messolonghi lagoons, *etc.*, most of them as SPAs[2].

Extensive information campaigns have been carried on in the Alonissos Marine Park to limit the impacts of tourist influence on monk seal populations through seal watching. In some protected coastal areas, endeavours to make the best use of the seabed have been made (diving, *etc.*). The sites chosen are those where fishing has lately declined markedly and no protected or threatened species are present. These are protected areas meant to restore and revitalize marine areas that are already degraded and concurrently support tourist activity. Such attempts have been made in Milos-Kimolos-Polyaigos-Thira-Theresia and along the west coast of Attica.

Some tourist websites[3] give information on the possibility of visiting areas of biological interest, such as the loggerhead turtle beaches in Zakynthos Island, the Alonissos Marine Park and the northeast coasts Evia Island (monk seal), activities seen as eco-tourism or 'ecological tourism. The sites offer a certain amount of information on protected areas, national parks, marine parks (particularly the zoning of this park), on the status of endangered species, on the institutions and NGOs entrusted with preservation (the Greek Monk Seal Protection Society-MOM, for example). In addition, they offer literature (books like Birds of the Aegean or Important Bird Areas of Greece are even available online). Nonetheless, there is nothing on how tourists should behave in the face of the challenges of threats to environments and wildlife due to the disturbance caused by tourism (Aggarwal and Tiwari, 2014).

2 Special Protection Area EC Directive.

3 Hellas-Guide : http://www.hellas-guide.com/eco_tourism/index.html.

V. Stability parameters

In the frame of the Co-Evolve4BG project, a set of parameters has been developed to provide an overview of the existing resources related to habitat and endemic species at both the national and the Mediterranean scales. This set is composed of ten parameters, as presented in Table 1. Data relevant to these parameters were collected at the national and regional scales.

Table 5. Habitat and Endemic Species parameters

Parameters	Description	Source
Name of dominant endemic species	Provide the name of Endemic species in the region: (*Posidonia oceanica*)	(Malea, 2019), (Elafrou, 2020), (Ministry of Environment, 2014)
Total Number of Endemic species	Indicate the total number of Endemic species existing in the region: **79**	(Coll et *al.* 2010), (Ministry of Environment 2014)
The pressure of touristic activities (Diving, cruise) on the Endemic Species	Determine if the presence of coastal/maritime tourism activities represents pressure to the endemic species: Yes for species living in coastal areas, marine parks, protected areas, Natura 2000 areas, exposed to tourist activities	(Aggarwal and Tiwari, 2014), (Ministry of Environment, 2014)
Name of Protected Area	Provide the name of Protected Area in the region: Details in chapter 4	
Number of the Protected coastal areas	Indicate the total number of Protected Areas in the region: 4.1 and 4,2 in the current document	
Location of coastal Protected Areas	Indicate the location of the protected areas (Maps) : (Annex I – Figs. 12 and 14)	
Number of Coastal protected areas allowing touristic activity	Indicate the number of Protected Areas which allow tourist activities inside it: 2 (Alonissos Marine Park, Zakinthos Marine Park)	Details in chapter 4
Name of dominant Invasive Species	Provide the name of Invasive species in the region: mainly *Mollusca, Arthropoda, Chordata, and Annelida*	(Katsanevakis *et al.* 2013), (Zenetos *et al.* 2011)
Total number of Invasive species	Indicate the total number of Invasive species existing in the region: 25 Marine, coastal, and water flora species and 375 (235 marines, 86 freshwater and brackish, six range expansion/ vagrant) species	(Zenetos *et al.* 2011), (Arianoutsou *et al.* 2010)
Impact of invasive species on ecosystems and tourist activities	Determine if invasive species are affecting the ecosystem and tourism activities in the region: All invasive species affect the ecosystem. More details in 3.3 Alien Species	www.naturagraeca.com

VI. Conclusion

With over 16,000 km. of shoreline, Greece has the most extended coastline of all Mediterranean countries. Greek combines a unique marine ecosystem with great endemic species colonies. However, even If the marine ecosystem biodiversity studies, projects, and organizations are in great numbers, recordings on endemic marine species are partial and incomplete. Greece belongs to European Union, and it is mandatory to complete the datasets regarding the habitats, protected areas and species on them. However, there are continuous efforts to create a complete inventory of endemic marine species in Greece, and even less on their status, geographic distribution, and influence factors. The data reported in this work was collected from scientific articles, doctoral theses, and scientific reports. They are fragmentary and scattered, and endemic species are generally mentioned incidentally in most scientific works. Therefore, this report's list of endemic species is not exhaustive, mainly focusing on habitat characteristics, distribution, and the Mediterranean Sea level data.

Several factors affect biodiversity and endemic species and most often act concurrently. These include climate change, urban and industrial discharges, excessive fishing, tourism, and biological invasions. In Greece, invasive species that have produced problems for indigenous species and biodiversity have already been recorded. This fact makes the approval of preventive measures a crucial priority, starting with the study and detection of the invasive alien species already present in the country and the detection of the way in which they have been introduced, to take the measures necessary to stop the spread of the invasion of these species.

The marine mammals of the Western Mediterranean and especially the Aegean Seas remain a vital habitat for these animals. The area includes eight marine mammals out of the nine residents of the basin. This distribution pattern has also been recorded for visiting marine mammals. The central Mediterranean and Aegean seas observed two of the three resident sea turtles (loggerhead, green, and leatherback turtles), while the two visiting turtles were absent from the eastern side.

This deliverable represents the very first thorough study on endemic species under the impact of tourism and other environmental/anthropogenic factors. The temporal monitoring of these species will make it feasible to develop the list of endemic species and evaluate the evolution of their status, principally in areas under tourist activities. This will help decision-makers and managers select strategies and economic development plans that are more respectful of the environment and ensure the preservation of the endemic species.

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ANNEX I

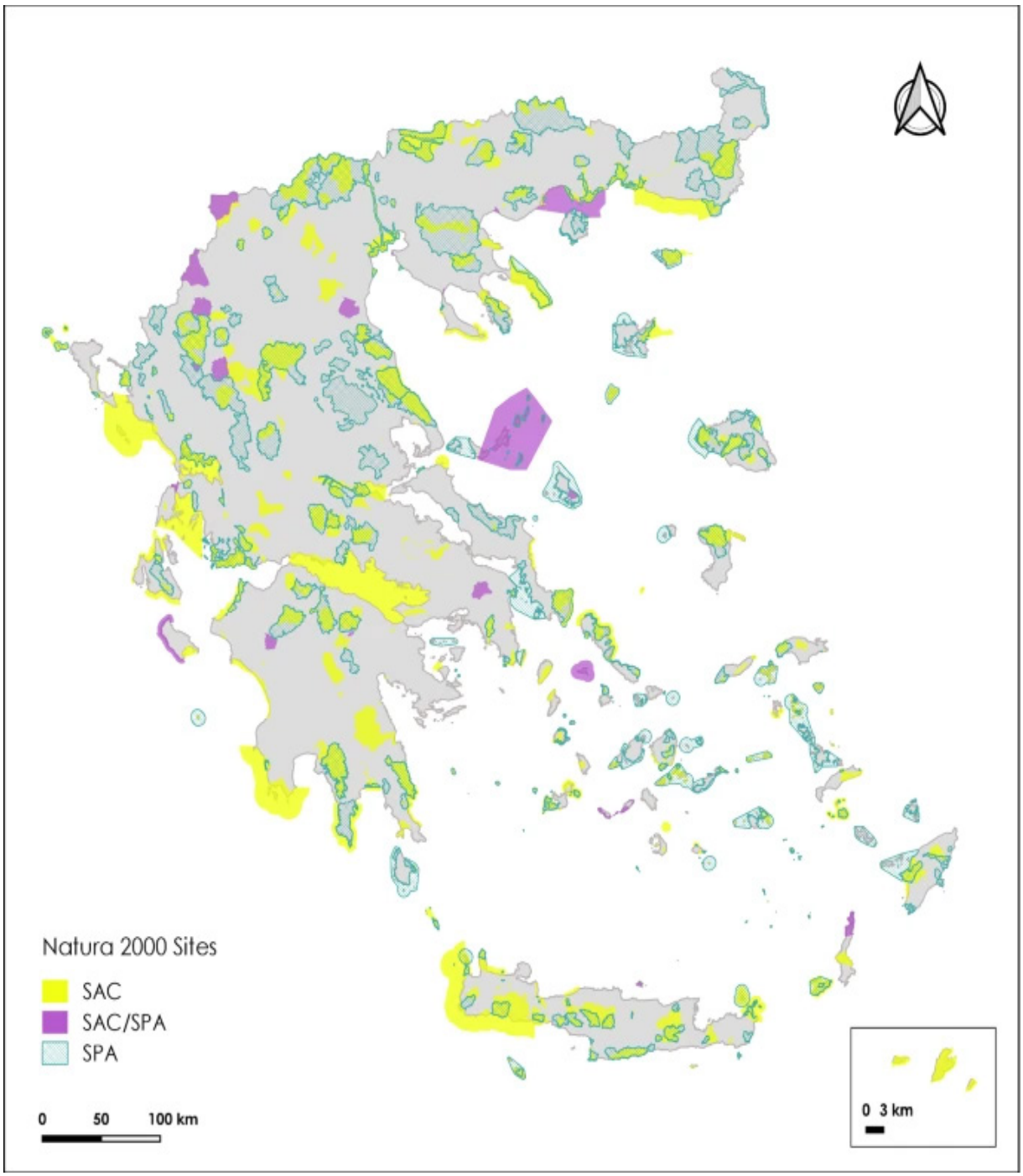

Figure 12. The Natura 2000 network in Greece. Yellow represents Special Areas of Conservation (SACs), light blue stripes represent Special Protection Areas (SPAs), and purple represents sites that are designated as both SAC and SPA (Spiliopoulou *et al.* 2021)

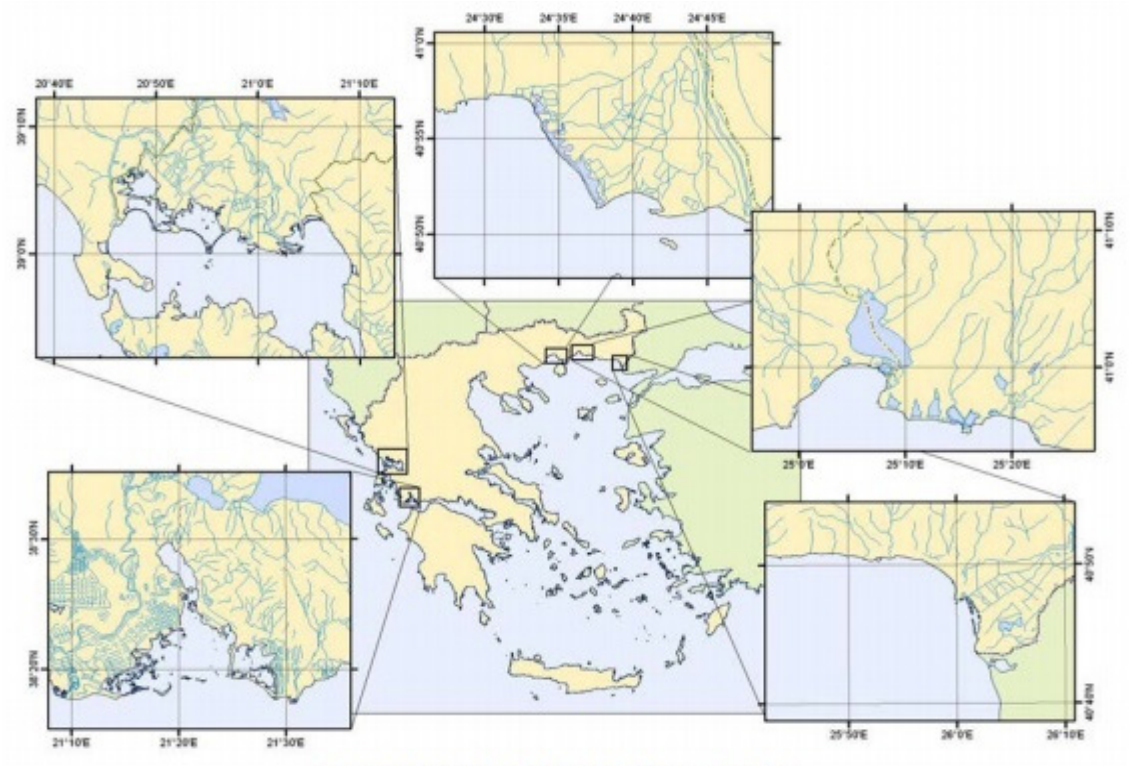

Figure 1. The main lagoon systems in Greece

Figure 13. The main lagoon network in Greece (Cataudella *et al.* 2015)

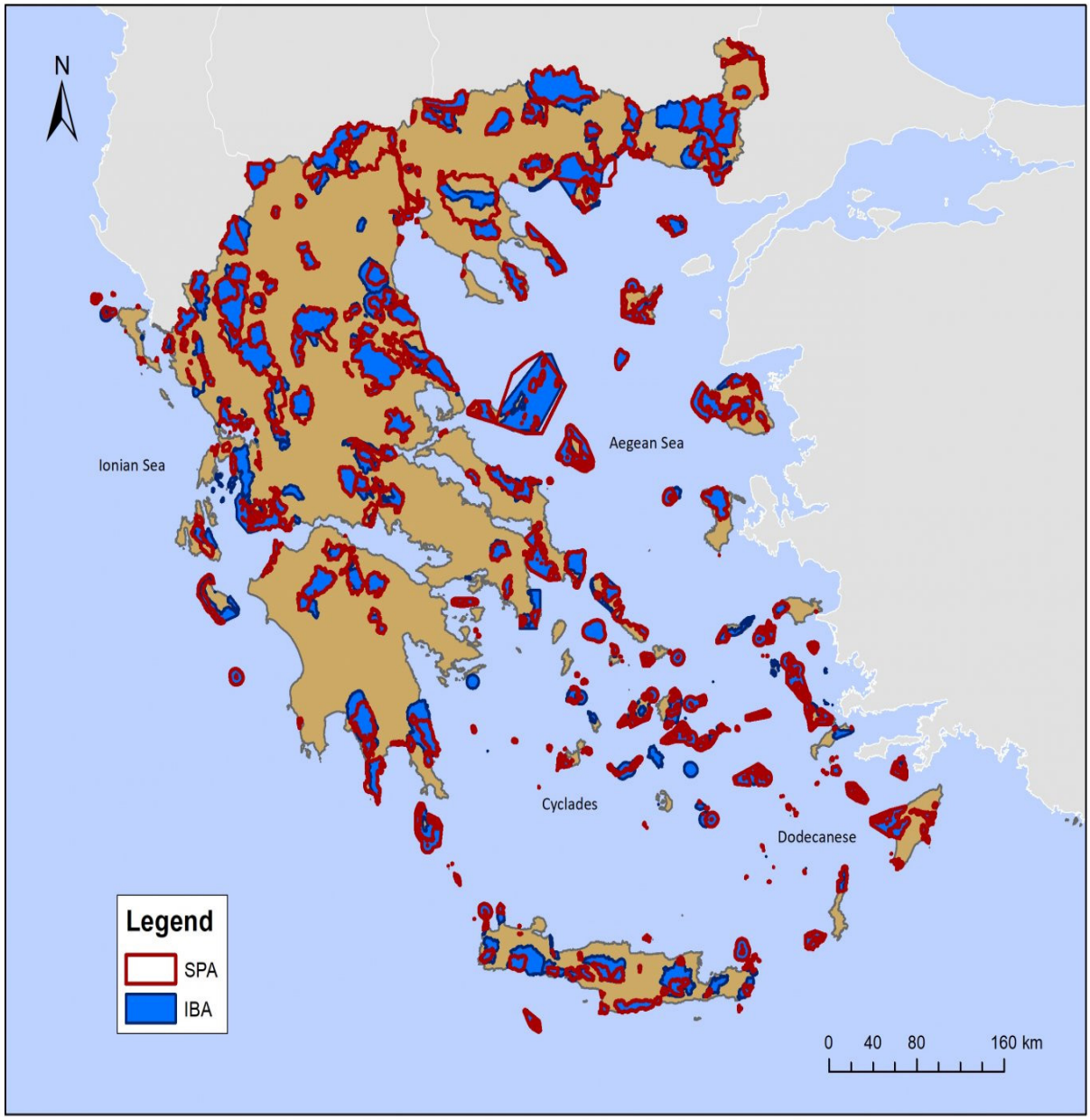

Figure 14. Ninety-five sites (32 new and 63 extensions of existing sites) have been added to the Greek network. These regions are almost marine and cover the marine Natura 2000 network from just 6% of Greek national waters to 22%. Overlap between the marine network and marine IBAs (Important Bird and Biodiversity Areas identified by BirdLife) has now fallen to 85 percent. (https://www.birdguides.com/)

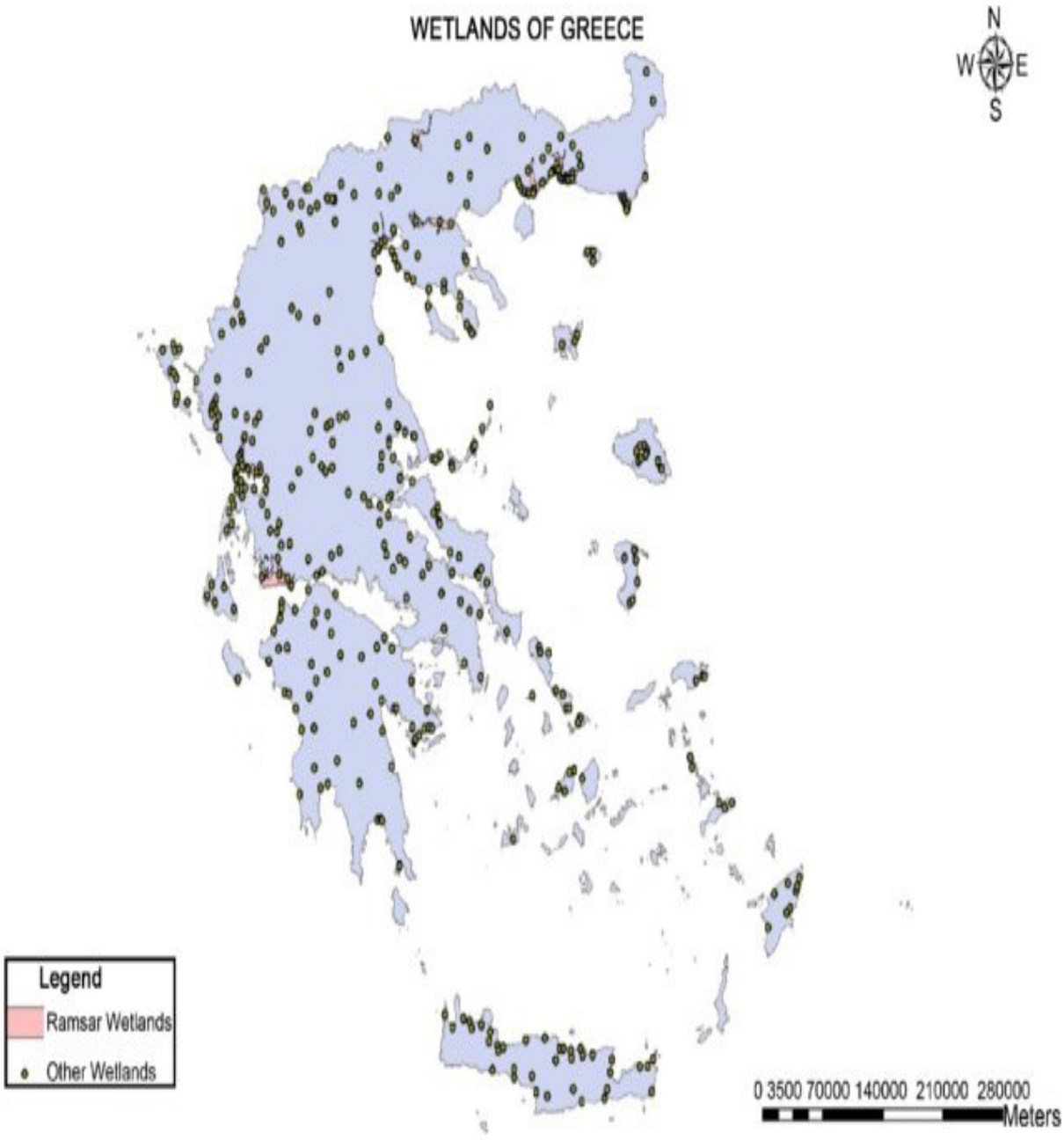

Figure 15. Map showing the wetlands of Greece. R = the Ramsar wetlands (http://www.ekby.gr/ekby/en/EKBY_Publications_en.html).

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