Marine conservation challenges in an era of economic crisis and geopolitical instability: The case of the Mediterranean Sea

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Abstract

In the Mediterranean Sea, socio-economic drivers may accelerate the process of Exclusive Economic Zone (EEZ) declarations. Despite the challenges, the EEZ declarations may provide important opportunities for leveraging change to national policy towards the development of large-scale conservation of marine ecosystems and biodiversity in this zone. Using the Mediterranean Sea as a case study, we aim to highlight a set of best practices that will maximize the potential for the development of large-scale marine conservation initiatives. These include a range of approaches, such as using surrogates to fill the many biodiversity data gaps in the region, further the development of consistent and open access databases, and the utilization of technological developments to improve monitoring, research and surveillance of less accessible and under explored marine areas. The integration of Mediterranean-wide and local conservation efforts, the facilitation of transboundary collaboration, and the establishment of regional funds for conservation will further enhance opportunities for marine conservation in this region.

Keywords: Marine conservation, Exclusive Economic Zones, Mediterranean, transboundary collaboration, data gaps, conservation opportunities.

1. Introduction

1.1 Towards EEZ conservation planning

Spatial prioritization is challenging at large scales, especially when following an integrated approach that accounts for biodiversity features, threats to ecosystems, the feasibility of conservation actions and related costs [1,2]. While terrestrial conservation planning has rapidly advanced in recent decades, large-scale marine conservation prioritization, which includes socio-economic and political factors, remains challenging and underexplored. This is partially due to difficulties in obtaining data on the distribution of biodiversity and human activities, and the fact that many marine areas have an ambiguous jurisdictional status [3].

The right to establish an Exclusive Economic Zone (EEZ) is considered to be one of the most important provisions of the United Nations Convention on the Law of the Sea (UNCLOS) (Table S1a). EEZs are defined as marine areas extending up to 200 nautical miles from the baselines from which the breadth of the territorial sea is measured. Within an EEZ, the coastal state has sole exploitation rights over all natural resources, but also the responsibility for the conservation and management of the zone (Article 61 of UNCLOS). In many countries around the globe, the declaration of EEZ has catalyzed marine conservation efforts offering new wide-ranging opportunities (Table S2).

Several countries have established or are in the process of establishing conservation areas and networks of Marine Protected Areas (MPAs) within their EEZs. Often this is set within a broader framework of marine spatial planning (Table S2). Marine spatial planning is the process of analyzing and allocating the spatiotemporal distribution of human activities to achieve specific ecological and socio-economic objectives. It has emerged as a tool for resolving inter-sectorial disputes over maritime space [4,5]. Conservation planning places emphasis on the protection of ecological features and processes, and the persistence of biodiversity and other natural values [6,7]. These two approaches have started to converge within an overarching framework of ecosystem-based marine spatial management [5,8,9], and may often overlap in practice (Table S2).

The main aim of this work is to analyze the challenges and the opportunities for EEZ-scale conservation within an ecosystem-based marine spatial management approach, focusing on the Mediterranean Sea as a case study.

1.2 The Mediterranean Sea: a model for the world's oceans

The effective protection of biodiversity requires that nature conservation targets are reconciled with social, economic, cultural, and political needs. One of the best case studies for building a framework for marine conservation planning in a complex geopolitical context is the Mediterranean Sea. This basin has been described as a miniature ocean that can serve as a mesocosm of the world's oceans in order to investigate the impacts of climate change and other natural processes [10,11]. This also applies for the socioeconomic and political context. The Mediterranean Sea is a semi-enclosed sea (2,969,000 km^2) connecting three continents, surrounded by over 20 countries [12]. Inherent geopolitical complexity and the diversity of political, cultural, and legal systems have raised obstacles to marine conservation efforts, which are currently largely confined in coastal territorial waters [2, 13–15].

*** Fig.1 about here ***

In addition to the large diversity of species and habitats that the Mediterranean Sea hosts, there is wide variety of bathymetric and geological features, from shallow seagrass meadows and rocky reefs to deep trenches and hydrothermal vents [12, 16–18]. Due to increasing levels of human use and the associated threats to biodiversity [19, 20] (Fig. 1), the Mediterranean marine ecoregions are among the most impacted globally [21, 22].

Despite many efforts for regional-scale conservation planning and increasing agreement on priority areas for conservation [23], the targets set by the Convention for Biological Diversity are far from being achieved in the Mediterranean. Existing MPAs currently cover only about 4.6% of the region, with merely 0.1% under strict protection or designated as no-take reserves [14] and underrepresentation of off-shore areas [13].

*** Fig. 2 about here ***

The inherent geopolitical complexity and disputes over marine borders and jurisdictions (Fig. 2; Table S3) have raised obstacles to EEZ declarations and marine conservation efforts offshore in the Mediterranean. However, many of the drivers for EEZ declaration will expedite the process in the near future (see Section 2). This situation poses challenges to large-scale conservation planning in the EEZs of this region. Conversely, this could be a unique opportunity for the development of a coordinated regional conservation effort.

The Mediterranean Sea is unique in the fact that once all countries declare their respective EEZs there will be no 'High Seas'. This will make the EEZ a basic administrative unit for marine spatial planning and marine conservation [24]. Consequently, the legal obligation to protect biodiversity and manage marine resources within an EEZ will provide an unprecedented opportunity to expand the spatial scale of conservation planning in the Mediterranean. Concurrently, there will be an opportunity to improve international coordination and integrate conservation efforts. The offshore areas of the region face reduced threats compared to the coastal areas, yet at the same time they include several biodiversity hotspots (Figs. 1 & 3).

2. Drivers for EEZ declaration in the Mediterranean

The relevant legal instruments applicable at global, regional, and European level (Tables S1a & S1b) provide a wide-range of regulatory frameworks for environmental protection in the Mediterranean Sea. However, important legal instruments, such as UNCLOS, have not yet been signed and ratified by all Mediterranean states (Table S1a), while the level of application of these instruments varies widely among parties. A broad range of EEZ boundaries, ecological zones, fisheries zones, and ecological and fisheries zones further complicate the situation. Some countries have a large number of potential EEZ boundaries [15], which suggests that successful conservation actions may depend on transboundary collaboration [25], the resolution of geopolitical or socio-economic conflicts, or mutual exploitation [26]. Overall, there are over a dozen marine border disputes in the Mediterranean Sea (Fig. 2; Table S3) that complicate the declaration of EEZs. In some instances these have led to military crises, such as the case of the Imia/Kardak conflict between Greece and Turkey in 1996 (Table S3).

*** Fig 3 about here ***

However, multiple drivers for the acceleration of the EEZ declarations have recently emerged. These drivers, acting independently or synergistically, have forced multi-lateral discussions and negotiations, and even unilateral decisions by some countries to declare their EEZ.

Vital economic and political interests of States to secure marine resources can lead directly to the declaration of an EEZ. Coastal states located within geopolitically unstable regions may have greater incentives to secure independent energy resources (Box S1 in Suppl. Material). The recent European sovereign debt crisis has severely struck the EU Mediterranean countries leading to a series of austerity measures and tough bailout programs [27]. In their struggle to recover from the crisis many governments are looking at fossil fuel reserves to reduce energy costs. In Greece the prospect of offshore gas and oil reserves in the Aegean and Ionian Seas are heralded by many politicians as the future 'El Dorado' that will save the country from bankruptcy. Similarly, the exploitation of hydrocarbon resources is closely linked to the recovery of the Cypriot economy. A direct result of this was that Cyprus and Egypt signed an agreement on their EEZs in 2003 [28]. Later Cyprus and Israel also agreed on the borders of their EEZs and to cooperate in the discovery and exploitation of joint hydrocarbon resources.

Ever progressing drilling technologies, dwindling shallow reservoirs, together with a rise in oil prices and demand for natural gas, encourage the hydrocarbon industry to explore and drill ever deeper [29]. Most of the large hydrocarbon discoveries in the eastern Mediterranean are within EEZs and in some cases on the border between countries (e.g. Israel and Cyprus). Plans for development are also being discussed in Western Mediterranean, e.g. in Spain. The viability of offshore drilling in the Mediterranean Sea is liable to speed up the process of EEZ declaration (Box S1 in Suppl. Material).

3. Challenges and concerns for EEZ-scale conservation

The declaration of an EEZ brings a series of challenges and concerns for large-scale conservation efforts. The most important ones are highlighted below.

3.1 Data and knowledge gaps

A large amount of biological and geophysical information has been gathered in the Mediterranean through various national or international initiatives. However, most of the available data on the distribution of ecological features refers to coastal and shelf areas [30]. Fine-scale habitat mapping is largely lacking, especially in offshore waters and data-poor regions such as the southern and eastern Mediterranean [19,23,31]. Even broad-scale classifications of marine habitats are biased in favor of shallow habitats due to gaps in knowledge in deep-sea environments [17].

Data on the distribution of threats to ecological features and processes are also rather poor. Important elements such as trace metals, persistent organic pollutants, and oil pollution are irregularly monitored throughout the Mediterranean Sea. The multi-gear and multi-species nature of Mediterranean fisheries remains a stumbling block to quantify the real impact of fishing [32]. Different countries and regional bodies use different data collection protocols and levels of data aggregations, creating additional challenges to combine data and perform analyses at the relevant regional scale for shared stocks. Moreover, data on fishing effort and distribution is either unavailable or difficult to access in some regions [2,33]. The region is generally suffering from the problem of data ownership and accessibility [34].

*** Fig. 4 about here ***

The paucity of data and database accessibility issues - notably at a homogeneous cross-basin level as well as ecoregion - are a hindrance to the development of ecosystem-based marine spatial management and marine conservation planning in general [31]. They impair the ability to calibrate oceanographic and ecological models, prevent the calculation and standardization of indicators, and restrict cross-border scientific collaboration. Habitat or species distribution models, when based on poor or limited datasets or global data, give predictions that might substantially deviate from field observations at regional levels (Fig. 4).

3.2 Monitoring, surveillance and enforcement

The offshore nature of EEZs makes the enforcement and surveillance particularly challenging. This task becomes even more difficult considering that a number of illegal activities, such as smuggling, piracy, illegal fishing, trafficking, waste dumping, and deliberate discharges from vessels take place in offshore areas [35,36].

To date, fisheries regulations in the Mediterranean Sea are poorly implemented. This poses special challenges for fisheries of shared or widely distributed stocks (such as bluefin tuna). The occurrence of illegal, unreported and unregulated (IUU) fishing not only in the high seas but also in "poorly regulated" EEZs [37] poses a challenge for the design, establishment and enforcement of MPAs within these zones [38–40]. Economic gains from IUU fishing are very high (up to U.S. $ 23 billion per year; [41]), exceeding the expected cost of being apprehended, thus the potential for non-compliance is also high [37].

3.3 Increased pollution risks from hydrocarbon exploitation

Ultra deep-water hydrocarbon exploration (>1500 m depths) is at the technological forefront of the industry. Ultra-deep drilling and pipe-laying are particularly risky in terms of their potential impacts on biodiversity and ecosystems [42]. The Gulf of Mexico disaster demonstrated that deep-sea spills can have fundamental environmental and conservation impacts impacting both pelagic and benthic habitats [43]. In the eastern Mediterranean, exploratory drilling in the Leviathan gas well caused a major leak of brine in May 2011 (12-14 thousand barrels per day). Fortunately, it was brine that seeped out of the well and not hydrocarbons, but this event demonstrates the technical and engineering difficulties associated with such deep drillings. Oil and gas exploration and exploitation have also operational impacts on the environment which may affect conservation efforts, such as noise pollution, chemical discharge from drill cuttings, drill mud and routine operations [44,45], as well as a possible avenue for invasive alien species [46].

3.4 Environmental and conservation issues lower in the agendas

Citizen concern over environmental issues has been declining since 2009 globally, and by the end of 2012 had reached a twenty-year low [47]. In Europe, unemployment, the strained economic situation, inflation, and government debt are the main concerns of citizens at national level, while the environment, climate change, and energy issues are ranked 11th in the list [48]. It is obvious that the economic crisis has shifted environmental and conservation issues lower down the political agenda, thus having important implications on conservation efforts. This is more evident for the marine than the terrestrial environment [49], and even more chronic for its offshore part, due to the lack of public familiarity with this region and the absence of easily observable impacts.

The economic crisis and declining importance of environmental issues in public perception may affect conservation efforts in the Mediterranean in various ways: (1) Reduced funds for conservation, e.g. the designation of some Spanish marine reserves have been stalled because of fiscal and macroeconomic difficulties [50]; (2) intensification of environmental transformation through exploitation, as a diverse range of economic actors - from individuals and households to industries and governments, struggling to survive the crisis - accelerate their efforts to turn environmental assets into marketable commodities or even subsistence goods [51,52,53]; (3) environmental safeguards are often reduced due to the governmental efforts to promote investments through fast-track laws (e.g. law 3894/2-12-2010 in Greece aiming to speed up strategic investments also in coastal and marine areas, and proposal of Strategic Investment Law in Croatia) and non-transparent procedures; (4) financial agendas can disrupt conservation success stories (e.g. flamingo case in the Mediterranean; [54]; and (5) increase of poaching and other illegal activities [51,53].

3.5 Lack of sufficient funding for conservation

Conservation funds are regularly restricted. Offshore research and conservation are expensive and have little direct association to the day to day life of the citizen. Hence they are low in the agenda of policy makers. It has been estimated that in coming decades, unfunded conservation needs will average between \$1.9 billion and \$7.7 billion annually (http://woods.stanford.edu/western-conservation-finance-bootcamp).

In recent years, attempts were made to overcome the traditional reliance on public funding and philanthropic grants for conservation. A set of tax benefits, markets-based instruments, and a diversity of trusts were all developed with the aim to expand the funding base of conservation and mainstream it within the wider economy. These finance structures are more prevalent in the terrestrial realm, with the marine environment being a more difficult 'sell'.

4. Overcoming bottlenecks – conservation opportunities

4.1 Considerations for EEZ conservation planning

Conservation planning within EEZs should be based on the same fundamental principles as planning in territorial waters [23]. Accounting for stakeholder involvement, opportunity costs, connectivity among protected areas, and complementarity of priority areas all remain important aspects in order to achieve the most efficient conservation outcome, i.e. the persistence of all species of concern with minimum cost. The implementation of appropriate systematic conservation approaches [55] and decision-support tools should allow for zoning taking into consideration the opportunity cost from conservation for various stakeholders, e.g. using Marzone [56]. Ideally, the designation of MPAs within EEZs will account for the trade-offs in benefits and costs of all users and stakeholders involved [2]. Spatial prioritization should not necessarily result in closures but instead in management tailored to the specific threats that an area faces. In the Mediterranean Sea, many efforts to map biological diversity and its associated threats have been made [12,19,20]. The next step would be to incorporate these threat maps within a framework that links threats to specific conservation actions and their associated cost, and the assessment of benefits (both ecological and financial) deriving from the recovery of species, habitats, and ecosystems [57].

4.2 Using surrogates to fill data gaps

Knowledge gaps are a serious bottleneck for efficient conservation planning, especially when shifting from coastal to offshore EEZ-wide conservation. While deep-sea ecosystems represent the largest biome globally, deep-sea species richness is still largely unknown [58]. Sampling deep-sea biota over large areas is time consuming and costly [59]. In the absence of biodiversity data, the use of geomorphological, physical, and chemical oceanographic features as surrogates for biological data has become common practice both in coastal and deep-sea ecosystems [60]. Ward et al. [61] found that habitat surrogates can be a cost-effective method for the identification of priority areas for conservation in coastal ecosystems. Similarly Anderson et al. [59] found that the geomorphology of seabed is a good predictor of biological assemblage composition and percentage cover of key taxa living in deep-sea biomes. Regions of the seabed with complex sedimentology, unusual high temperatures, and structural features are considered as areas of high biodiversity [58]. Howell [62] described a hierarchical classification system for the North Eastern Atlantic based on four surrogates useful at progressively finer spatial scales; biogeography, depth, substrate, biological assemblages. However, the limitations of surrogates should be taken into account and uncertainty analysis should be developed.

4.3 Developing free-access homogeneous databases

The absence of open access databases limits the applicability and contribution of future publicly funded programs for conservation planning in the Mediterranean Sea. This is an issue that needs to be resolved, especially in the current context of limited resources. This requires that existing data are made accessible, harmonized, standardized, and checked for quality [30]. In the “global information era”, ensuring data availability, interoperability, and quality should be a compulsory requirement accompanying any publicly-funded initiative [34]. In the past few years, several initiatives have emerged that gather data and make them available online through free-access databases, such as EASIN (European Alien Species Information Network; http://easin.jrc.ec.europa.eu/), EIONET (European Environment Information and Observation Network; http://www.eionet.europa.eu/) or MAPAMED (Marine Protected Areas in the Mediterranean; http://www.medpan.org/mapamed). Furthermore, data standards and protocols have been developed to improve interoperability.

4.4. Transboundary collaboration

Transboundary collaboration in marine conservation planning leads to substantial efficiencies over unilateral uncoordinated conservation [63]. It is particularly important to collaborate within ecoregions to achieve better representation of species, genetic and functional diversity [25,31,64]. For conservation of offshore areas and important conservation features (e.g. seamounts) that cross boundaries, the role of international organizations and their related mechanisms is critical.

Species, habitats, and physicochemical parameters, as well as pollution cross boundaries, thus creating strong interdependence between countries, especially when it comes to broad scale conservation planning. As such, transnational collaboration and coordination appear to be key factors in addressing EEZ-scale conservation issues. Networks of scientists as well as

NGOs play an important role in developing, maintaining and promoting exchanges between countries.

The United Nations Environment Program's Mediterranean Action Plan (hereafter UNEP/MAP), in cooperation with the European Commission, initiated a formal regional process for the identification of Ecologically or Biologically Significant Areas (EBSAs) in the Mediterranean (Fig. 5). This effort led to the identification of 12 such large offshore areas that were ultimately endorsed by all the contracting parties to the Barcelona Convention (21 Mediterranean countries and the European Union). Most of these areas encompass EEZs of more than one country, and many of them fall in high seas or disputed areas. To move this process forward, a major effort needs to be invested by all conservation actors and national governments in planning and implementation of protected areas and conservation zones within the agreed EBSAs [65]. Several efforts exist, varying extensively in their objectives and target species or habitats, identifying areas of conservation priority at different scales for the Mediterranean [23] (Fig. 5). Although these proposals contribute significantly to the identification of priority conservation areas in the Mediterranean Sea, none of them is embedded in a basin-wide binding legal framework, resulting in rather limited outcomes [65]. EEZ declaration has the potential to be quite important to moving the EBSA approach forward. With the existence of clear boundaries it will be easier for adjacent states to cooperate, and each country will have the responsibility and obligation to manage the part of the EBSA located within its EEZ. While the Mediterranean 'high seas' still exist, the responsibility for their conservation will also depend on the cooperation of third party States.

*** Fig. 5 about here ***

The future application of national jurisdiction to the current high seas could minimize irrational exploitation and the depletion of shared marine resources, known as "the tragedy of the commons" [66]. The full definition of EEZ designations will provide a consistent, predictable framework which will make it easier for states to not only apply control over their adjacent marine areas but also cooperate with other neighboring states. This could lead to the development of multi-country scale and Mediterranean-scale conservation planning utilizing regional instruments such as the Barcelona Convention and the European Union environmental legislation (Table S1).

4.5 Joint management zones and dispute settlement

Joint management zones can facilitate faster cooperation among riparian states [67]. A joint maritime zone can be a peaceful option for dispute settlement where parties do not fully agree on delimitation, for example in the Eastern Mediterranean Sea, where several claims have existed already by some coastal countries. Recent development of the oil exploration and exploitation in the Eastern Mediterranean Sea shows that the states are reluctant and persistent for boundary negotiation. Thus, difficulties can be overcome with new and cooperation-oriented solutions to settle for common profits, prosperity and sustainable use of resources with peace [26,68]. The development of multinational management of large marine ecosystems has been promoted in numerous regions including the coral triangle and the Mesoamerican reef system [69,70].

4.6 Improving monitoring and surveillance

Securing appropriate monitoring and surveillance within EEZs is a prerequisite for successfully implementing conservation actions. Surveillance, especially in offshore areas, can be strengthened by technological means such as Vessel Monitoring Systems (VMS), Vessel Detection Systems (VDS), Automatic Identification Systems (AIS), radar, aircraft support, and even satellite observation platforms. However, the high cost of these integrated surveillance systems may not be a feasible solution for a number of states facing serious economic problems. Partnerships between governmental and private NGOs or foundations might enhance the surveillance and enforcement potential, as e.g. between the Galapagos Marine Reserve and the Sea Shepherd Conservation Society [71]. The integration of MPA surveillance into national marine security and national intelligence systems could prove quite effective and would decrease costs by reducing redundancy. Military systems have powerful technologies and many more assets than non-military agencies and could greatly assist the surveillance of vast marine areas. For example, the U.S. Coast Guard has maintained broad responsibilities for enforcing offshore MPAs established under federal authorities [72]. The use of ROVs for monitoring biodiversity of the deep seas has been ongoing for several decades, however the use of Unmanned Aerial Vehicles (UAVs) for conservation is new but has the potential to expand exponentially due to the low cost [73,74].

Currently, the EU system for fisheries controls makes extensive use of modern technologies such as VMS, VDS, and AIS to ensure that fishing fleets are effectively monitored and controlled (http://ec.europa.eu/fisheries/cfp/control/index_en.htm). Such control systems are applicable to the EU EEZ and offer efficient and cost-effective solutions for surveillance to EU member states. New research is being done in the European Commission's Joint Research Centre and elsewhere on innovative sensors for maritime surveillance (http://ipsc.jrc.ec.europa.eu/?id=318). By increasing the likelihood of sanctions due to better surveillance of EEZ waters, and thus raising the opportunity cost of non-compliance, compliance can be expected to increase.

4.7 Creation of a Conservation Fund

Currently, the EU is coordinating its legal and financial instruments to push for a Blue Economy, or Blue Growth in the fields of marine mineral resources, maritime-coastal-cruise tourism, aquaculture, ocean renewable energy, and blue biotechnology. As such, there is room to operate regional-scale trusts that reserve a portion of the revenue from resource exploitation for conservation and that allocate a further portion for risk mitigation and insurance. Such mechanisms exist at a national scale (e.g., Norway for the marine realm and in Israel for the terrestrial environment) but do not exist at regional level, such as the Mediterranean marine environment. It is likely that regionally coordinated conservation financing could lead to greater efficiencies in implementing new mechanisms and in using the limited and much-needed conservation funds, whose scarcity have become more acute during the financial crisis.

5. Concluding remarks

Despite the new multifaceted challenges associated with the expansion of the state sovereignty to the EEZs in the Mediterranean Sea, significant conservation opportunities were highlighted. The suggestions provided, regarding conservation opportunities and overcoming difficulties are not restricted to the countries of the Mediterranean Sea but are likely applicable to many regions all over the globe. Collaboration is a fundamental concept for the successful management and conservation of shared resources between states. In many instances the need for transboundary coordination will require adjacent states to develop structures to resolve disputes and take forward economic opportunities for the benefit of all parties. In the Mediterranean Sea but also globally, there is an opportunity for the marine conservation community to step forward and be part of the planning process to protect vital areas of the EEZs.

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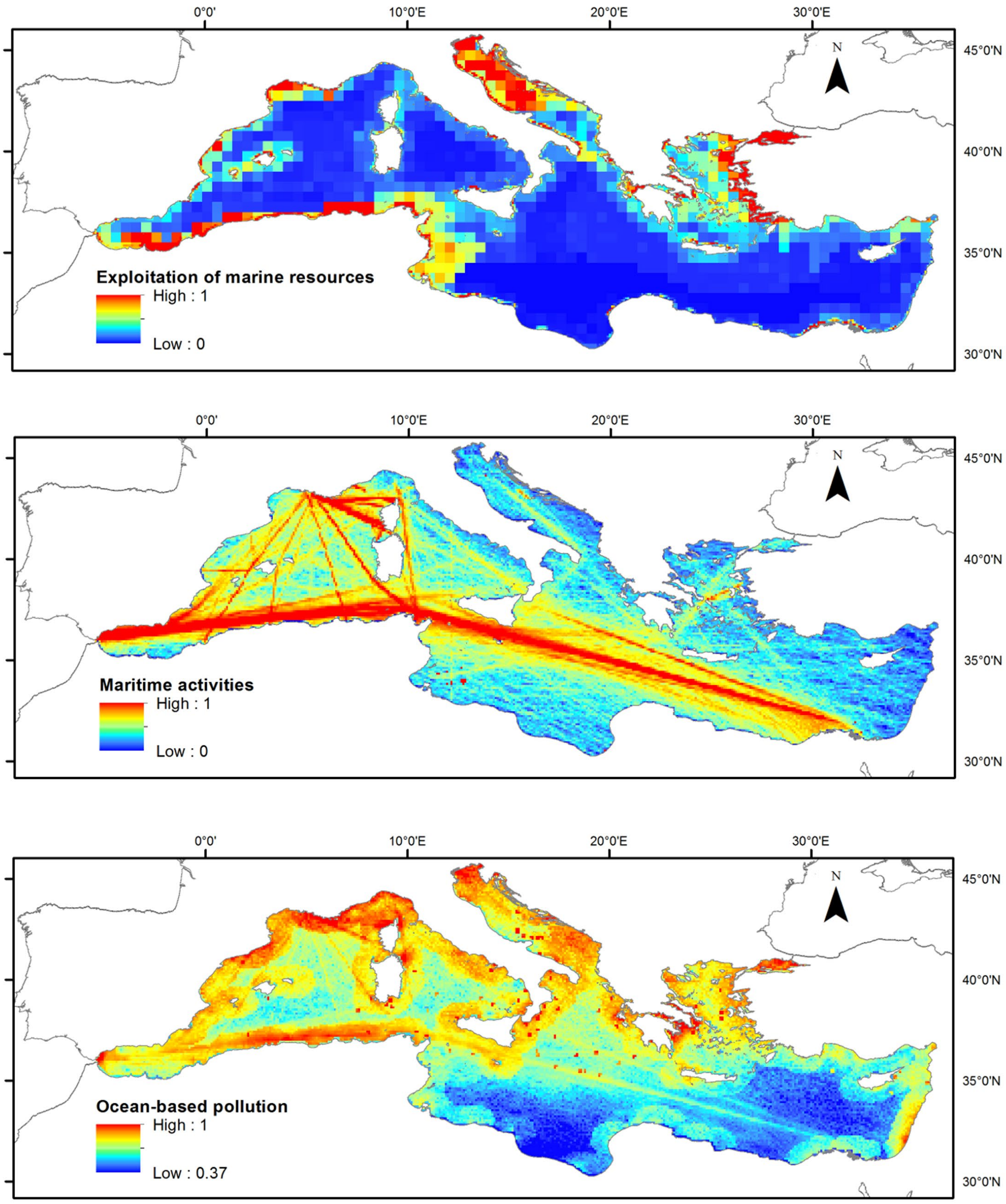

Figure 1: Examples of human activities in the Mediterranean threatening conservation efforts (adapted from [19]).

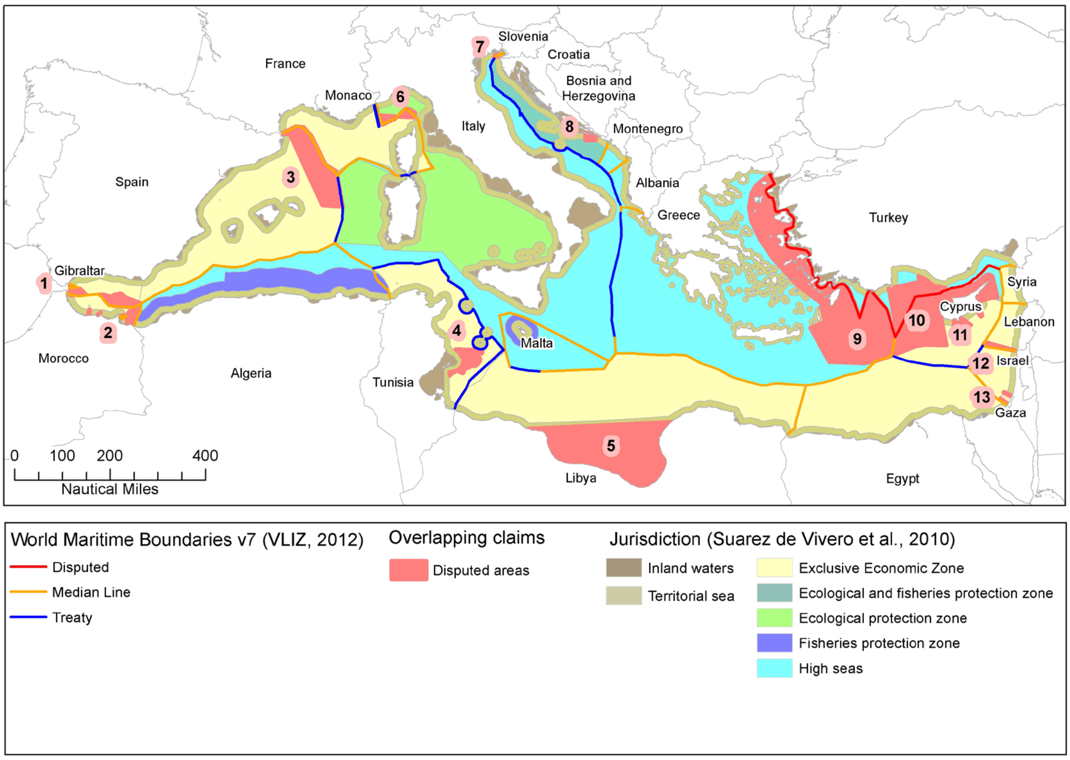

Figure 2: Marine boundaries and disputes in the Mediterranean Sea. See Table S3 for details on the disputed areas.

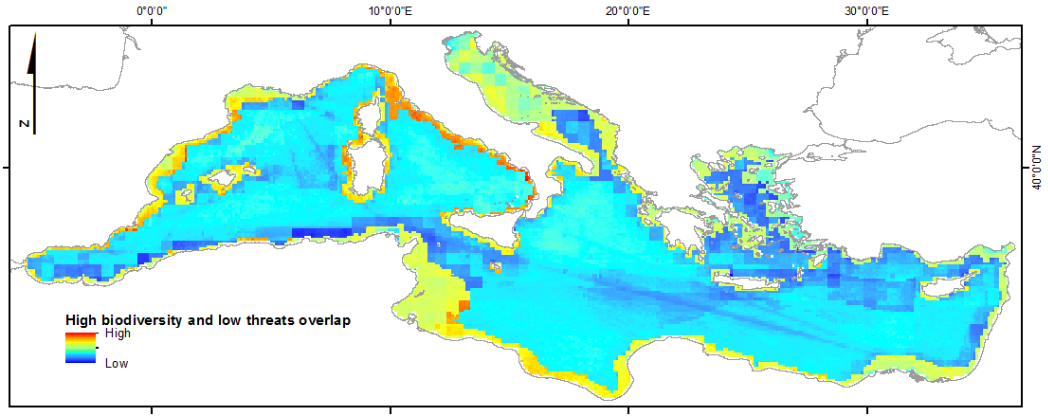

Figure 3: Areas with high diversity of fish species under IUCN categories, and low cumulative threats. Details on the methodology applied for this analysis may be found in the Supplementary Online Material.

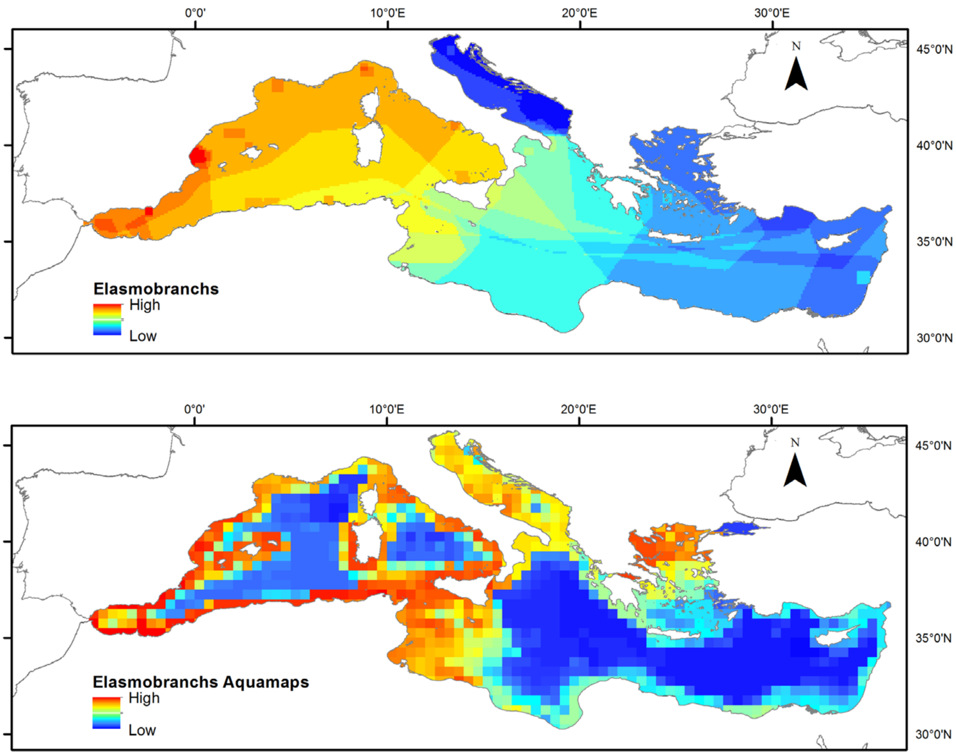

Figure 4: Dependence of species distribution models on the quality and representativeness of available data. Different estimated patterns of elasmobranches species richness in the Mediterranean Sea using expert knowledge data (top panel) and predicted results from species distribution models (bottom panel) (modified from [12]; see Supplementary Online Material for details on the methodology).

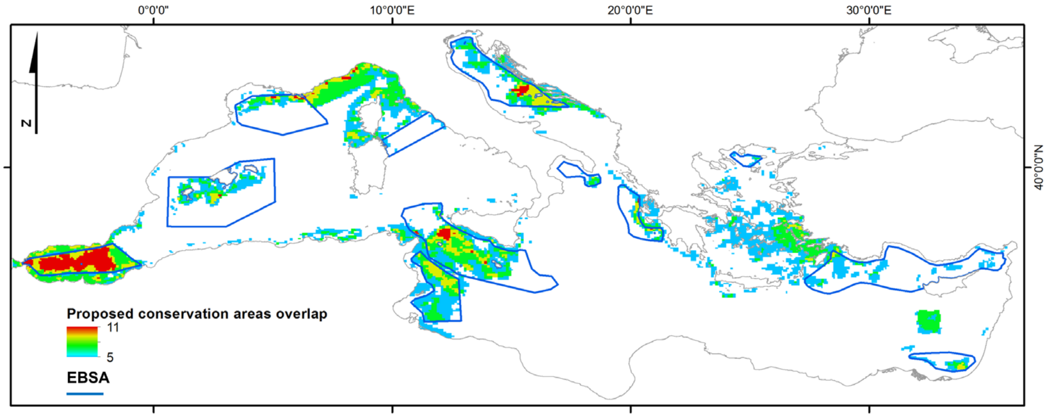

Figure 5: The Ecologically or Biologically Significant Areas (EBSA) proposed in the Mediterranean Sea (adapted from UNEP-MPA RAC/SPA) and consensus areas of high conservation value as identified in [23] based on the overlap among proposed conservation plans (the overlap of at least 5 plans is shown).