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Meeting of the Correspondence Group on Monitoring (CORMON), Biodiversity and Fisheries

Madrid, Spain, 28th February – 1st March 2017

Agenda item 7: Progress in the preparation of the 2017 Mediterranean Quality Status Report related to biodiversity and NIS (EO1-EO2)

Preliminary Assessment Factsheets for the IMAP common indicators related to Biodiversity and NIS

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FOREWORD

At the 19th Ordinary Meeting (COP 19) held in February 2016, the Contracting Parties to the Barcelona Convention adopted the Integrated Monitoring and Assessment Programme (IMAP) and agreed on a set of 23 Common Indicators and 4 Candidate Indicators. They also agreed that the Quality Status Report of 2017 (QSR2017) will build on the structure, objectives and data collected under IMAP.

Within the framework of the process launched to elaborate the QSR2017, SPA/RAC with the help of specialised experts prepared a preliminary version of the Assessment Factsheets for the following indicators:

- Habitat distributional range (EO1) to also consider habitat extent as a relevant attribute;
- Condition of the habitat's typical species and communities (EO1);
- Species distributional range (EO1 related to marine mammals, seabirds, marine reptiles);
- Population abundance of selected species (EO1, related to marine mammals, seabirds, marine reptiles);
- Population demographic characteristics (EO1, e.g. body size or age class structure, sex ratio, fecundity rates, survival/mortality rates related to marine mammals, seabirds, marine reptiles);
- Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species, particularly invasive, non-indigenous species, notably in risk areas (EO2, in relation to the main vectors and pathways of spreading of such species);

The preliminary factsheets are included in the current document and will be presented at the forthcoming Meeting of the Correspondence Group on Monitoring (CORMON), Biodiversity and Fisheries (Madrid, Spain, 28th February – 1st March 2017) to inform the participants about the approach followed and provide them with the preliminary results of the assessments. Based on the views and recommendations of the CORMON Biodiversity and Fisheries, a further elaborated version of the factsheets will be prepared and circulated for review by Email to the members of the Correspondence Group on Monitoring.

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Common indicators

1. **Common Indicator 1 and 2: Habitat distributional range and Condition of the habitat's typical species and communities (EO 1)**

Background and rationale for habitats and seafloor integrity, key pressures and drivers

In the list of EcAp Ecological Objectives and Common Indicators, *Habitat distributional range* and *Condition of the habitat's typical species and communities* belong to the Ecological Objective EO1 Biodiversity. The objective *Seafloor Integrity* is also included but, still, the common indicators need further development. "Seafloor" includes the physical and chemical variables of the seabed and the biotic composition of the benthic assemblages. "Integrity", besides covering the physical and biological components of the sea bottom, requires also that habitats are not artificially fragmented. However, there is no single scientific consensus on what constitutes "good environmental status" for Sea Floor Integrity. Baseline information are extremely scant so that also a consensus around the meaning of "integrity" is lacking.

Habitat destruction is one of the most pervasive threats to the diversity, structure, and functioning of Mediterranean marine coastal ecosystems and to the goods and services they provide (1,2,3,4,5,6,7,8,9). The 20% of the entire basin and 60-99% of the territorial waters of EU member states are heavily impacted by multiple interacting threats, less than 20% has low impact and very few areas, less than 1% remain relatively unaffected by human activities (10,11,12). The Alboran Sea, the Gulf of Lyons, the Sicily Channel and Tunisian Plateau, the Adriatic Sea, off the coasts of Egypt and Israel, along the coasts of Turkey, and within the Marmara and Black Sea are highly impacted. Low cumulative human impacts were found in offshore areas, and in several small coastal areas of some countries. These areas represent important opportunities for conservation aimed at preventing future degradation. Pollution, fisheries, urbanisation and invasive alien species (increasing temperature and UV, and acidification) are the most frequently cited pressures in the Red List of European Habitats (https://www.researchgate.net/publication/311772198_European_Red_List_of_Habitats_Part_1_Marine_habitats) affecting the distribution range and the conditions of habitats. Climate change is also affecting some mediolittoral and infralittoral habitats, especially by altering the thermal structure of the water column, with extensive mass mortalities (13).

The proliferation of coastal and marine infrastructures, such as breakwaters, ports, seawalls and offshore installations call for special concern, all being associated with loss of natural habitats and alteration of hydrographic conditions (14). New strategies aimed at elevating the ecological and biological value of coastal infrastructures are urgent. Seabed trawling causes the loss of shallow habitats such as *Posidonia* seagrass meadows and deeper soft bottom habitats. The continuous stirring, mixing, and resuspension of surface sediments by intensive and chronic trawling activities changes sediment dynamics and have permanently smoothed the seafloor morphology of the continental slope over large spatial scales. Commercial interest in deep-sea mining is increasing, relating to the future exploitation of seafloor resources. The environmental impacts of deep-sea mining could be significant, including physical disturbance, the creation of suspended sediment plumes, water mixing effects, and the impacts of mining ships and other infrastructure (15).

Policy Context and Targets

Marine Protected Areas (MPAs) are one of the most important tools for protecting marine-coastal habitats and seafloor integrity. Several institutions (e.g. RAC/SPA, MedPAN, WWF, local NGOs, IUCN, research organisations) are working together to set conservation priorities establishing an ecological network of MPAs to protect at least 10% of the marine and coastal waters (Aichi Target 11), made up of ecologically interconnected and well managed MPAs that are representative of Mediterranean biodiversity, in accordance with the latest guidelines from the Convention on Biological Diversity and the Barcelona Convention (see also the recent document http://www.europarc.org/news/2016/12/tangier-declaration/). MPAs are generally instituted because of the presence of remarkable benthic seascapes. The Birds and Habitats Directives (BHD) have led to the establishment of the Natura 2000 network of sites where species and habitats (9 marine habitats) of European interest must be maintained in a favourable conservation condition. The Ramsar Convention includes member states throughout the Mediterranean Basin and focuses on a single threatened habitat, coastal wetlands. Other Eurocentric policies include the Marine Strategy Framework Directive (MSFD), which requires the European States of the Mediterranean to prepare national strategies to manage and monitor their seas to achieve or maintain Good Environmental Status by 2020 in all their national waters. The definition of Good Environmental Status (GES) is based on two pillars: Biodiversity and Ecosystem Functioning (BEF). The conceptual revolution of GES overcomes the limits of both the Habitats Directive and the Landscape Convention, widening conservation not only to structure (biodiversity) but also to function (ecosystem functioning), considering many phenomena that do occur in the water column (16). In this framework, *habitat distribution*, *extent* and *condition* are included in Descriptor 1, while Descriptor 6 deals directly with *seafloor integrity*. Finally, there are other institutional mandates such as the EU Directive establishing a framework for Maritime Spatial Planning (MSP) and the EU Blue Growth strategy requiring that areas and actions are prioritized to ensure that conservation and management efforts will produce biological and socioeconomic long-term benefits. However, at present, the lack of concrete application of MSP, even at small scale, limits the potential to solve hot spots of conflicts with consequent effects on marine biodiversity and the services it provides. EcAp extends the vision of the MSFD to the whole Mediterranean, while taking into account its peculiarities.

Results of the assessment

A total of 257 benthic marine habitat types were assessed in a recent overview of the degree of endangerment of marine, terrestrial and freshwater habitats in the European Union (EU28) and adjacent regions (EU28+) (The European Red List of Habitats, 2016). In total, 19% (EU28) and 18% (EU28+) of the evaluated habitats were assessed as threatened in categories Critically Endangered, Endangered and Vulnerable. The highest proportion of threatened habitats in the EU28 is in the Mediterranean Sea (32%), followed by the North-East Atlantic (23%), the Black Sea (13%) and then the Baltic Sea (8%). This report provides also an overview of the risk of collapse for 47 benthic habitats in the Mediterranean. Almost half of the Mediterranean habitats (23 habitats, 49%) were Data Deficient in EU28 countries. Of the remainder (24 habitats) 83% were of conservation concern (NT-CR) with 63% threatened to some degree (42% Vulnerable and 21% Endangered). A good proportion of habitats in infralittoral and mediolittoral environments were either Vulnerable or Endangered. They include algal-dominated communities on infralittoral sediments, and circalittoral sediments and rocks together with mussel and oyster beds. The criteria under which habitats were most frequently assessed as threatened in both the EU28 and EU28+ were *decline in extent* and a *decline in quality*.

The brown algae ***Cystoseira* spp**. form dense canopies along rocky intertidal and subtidal rocky coasts. Conspicuous historical declines in extent and quality, for at least a century and especially of species thriving in rock-pools and in the infralittoral zone, are documented in many regions of the Mediterranean Sea (Adriatic Sea, France, Ligurian Sea, Strait of Sicily). Algal turfs replace canopies, with a shift from high- to low-diversity habitats. In many coastal rocky bottoms a shift from canopy-forming algae dominated system to overgrazed sea urchin-dominated barrens (*Paracentrotus lividus* and *Arbacia lixula*) can also occur, mainly in consequence of the illegal destructive fishing of the rock-boring mollusk *Lithophaga lithophaga* and the overfishing of primary sea-urchin predator fishes. Despite the progressive expansion of **barren areas** replacing algal canopies and other rocky bottom assemblages is currently widely acknowledged (Western and Eastern Mediterranean Sea), no published work has been aimed at the assessment of the extension of barren (1).

Kelps such as *Laminaria rodriguezii* are now confined to very deep areas of the Mediterranean Sea (Balearic and Alboran Islands). The few available temporal data from the Adriatic Sea, obtained in surveys undertaken between 1948–1949 and 2002, showed that this species has become exceptionally rare or has completely disappeared from this area. Repeated surveys in 2010 showed no recovery of the species. These losses have been linked to intensive trawling. In other areas of France, Italy and Tunisia the species records date back mainly to the 1960–1970s, while in this work recent accessible information on the status of these populations was not found. Only two habitats were assessed as threatened considering the *area of occupancy*: **biogenic habitats of Mediterranean mediolittoral rock** represented by vermetid molluscs and by red algae such as *Lithophyllum byssoides* and *Neogoniolithon brassica-florida*, and **photophilic communities** dominated by calcareous, habitat forming algae, as they are found at only a few sites on the European side of the Mediterranean Sea.

The distribution of **nursery areas** of 11 important commercial species of demersal fish and shellfish was assessed in the European Union Mediterranean waters using time series of bottom trawl survey data with the aim of identifying the most persistent recruitment areas (17). A high interspecific spatial overlap between nursery areas was mainly found along the shelf break of many sectors of the Northern Mediterranean, indicating a high potential for the implementation of conservation and management measures. The new knowledge on the distribution and persistence of demersal nurseries can further inform the application of spatial conservation measures, such as the designation of new no-take MPAs in EU Mediterranean waters and their inclusion in a conservation network. The establishment of no-take zones has to be consistent with the objectives of the Common Fisheries Policy applying the ecosystem approach to fisheries management and with the requirements of the MSFD to maintain or achieve seafloor integrity and good environmental status.

The first continuous maps of **coralligenous and maërl habitats** across the Mediterranean Sea has been produced across the entire basin, by modelling techniques (5). Important new information was gained from Malta, Italy, France (Corsica), Spain, Croatia, Greece, Albania, Algeria, Tunisia and Morocco, making the present datasets the most comprehensive to date. Still, there were areas of the Mediterranean Sea where data are scarce (Albania, Algeria, Cyprus, Israel, Libya, Montenegro, Morocco, Syria, Tunisia and Turkey) or totally absent (Bosnia and Herzegovina, Egypt, Lebanon and Slovenia). Knowledge on maërl beds was somewhat limited compared to what was available for coralligenous outcrops; a significant update was nevertheless achieved. Previously unknown spatial information on maërl distribution became available for Greece, France (Corsica), Cyprus, Turkey, Spain and Italy. Malta and Corsica, in particular, had significant datasets for this habitat as highlighted by fine-scale surveys in targeted areas.

A fine-scale assessment of (i) the current and historical known distribution of ***P. oceanica***, (ii) the total area of meadows and (iii) the magnitude of regressive phenomena in the last decades is also available (6). The outcomes showed the current spatial distribution of *P. oceanica*, covering a known area of 1,224,707 ha, and highlighted the lack of relevant data in part of the basin (21,471 linear km of coastline). The estimated regression of meadows amounted to 34% in the last 50 years, showing that this generalised phenomenon had to be mainly ascribed to cumulative effects of multiple local stressors.

Considerable efforts have also been carried out to address the issue of **alien species** at basin scale (18,19). There are considerable differences among the Mediterranean countries in the number of recorded alien species. Far more alien species have been documented in the Levantine Basin than the entire western Mediterranean, when considering multicellular taxa. More specifically, a total of 986 alien species in the Mediterranean have been recorded (775 in the eastern Mediterranean, 249 in the central Mediterranean, 190 in the Adriatic Sea and 308 in the western Mediterranean) (19). A total of 338 alien species was found only for the 180 km long coast of Israel, individuated as a hot spot for invasive species also (12,18), whereas 112 alien species were reported off the 2300 km long Mediterranean coast of continental France and Spain.

Our knowledge about the **deep-sea habitats** on the scale of the whole Mediterranean Basin is extremely scant and limited only to sites in the western Mediterranean which received much attention in the last decades (e.g., Cap de Creus Canyon, South Adriatic Sea, Santa Maria di Leuca Coral Province, Alboran Sea). The lack of information about deep-sea habitats in the north African and in the eastern side of the Mediterranean Sea is particularly evident.

Conclusions and identification of gaps

- Regional expertise, research and monitoring programmes over the last few decades have tended to concentrate their attention on only a few specific Mediterranean habitats. The exploration of habitats such as bioconstructions from very shallow to the deep-sea should be further supported.
- Despite the scientific importance of time series studies, the funding for many monitoring

programmes is in jeopardy, and much the Mediterranean Sea remains not just under-sampled but unsampled. Monitoring should be coordinated and standardized so that results can be easily comparable at least for some, decided *a priori*, variables.

- Beside criteria such as reduction in quantity and in quality and the geographical distribution, more research should focus on processes leading to low diversity habitats. Regime shifts are ubiquitous in marine ecosystems, ranging from the collapse of individual populations, such as commercial fish, to the disappearance of entire habitats, such as macroalgal forests and seagrass meadows. Lack of a clear understanding of the feedbacks involved in these processes often limits the possibility of implementing effective restoration practices.
- To make the descriptor Sea Floor Integrity operational 8 attributes of the seabed system have been suggested to provide adequate information to meet requirements of the MSFD: (i) substratum, (ii) bioengineers, (iii) oxygen concentration, (iv) contaminants and hazardous substances, (v) species composition, (vi) size distribution, (vii) trophodynamics and (viii) energy flow and life history traits. An important issue is to select the to select the proper spatial and temporal scales
- Increase the geographical coverage of protection, establishing new arrays of MPAs (and then Networks of MPAs) in the southern and eastern parts of the Mediterranean Sea (most MPAs are concentrated in the north-central Mediterranean Sea) since Descriptors 1, 3, 4 and 6 have been shown to evolve favourably in Mediterranean MPAs. The use of MPA networks as a reference volume where to assess the attainment of GES should be taken into account. The GES should be achieved in all Mediterranean waters by 2020. In addition, Establish Exclusive Economic Zones (EEZ) in EU countries and encourage other non-EU states to do so as well. This will minimize or eliminate the High Seas in the Mediterranean. Outside the EEZs, in fact, the seas are a “no man’s land” and regulations are weak, especially for deep-sea mining and fisheries.
- The coastal states are currently formulating their criteria and the associated monitoring protocols for recognising GES. This is leading to quite wide disparities of the interpretations of the Descriptors/Indicators among coastal states, not least in the ecological terminology used: this is particularly evident in the definition of Sea Floor Integrity (Descriptor 6) largely differing across countries such as Spain, Italy, Slovenia, Croatia, Cyprus and Bulgaria (1). The monitoring programmes also suffer of the same inconsistencies. The consequence is that, in most EU countries, the criteria for implementing GES are still unclear, with lack of harmonization of methods between countries.
- Large-scale analyses have been critical to expand our knowledge about the *extent* of habitats and threats but are often biased by the extrapolation of either a few small-scale studies or low-resolution large-scale assessments. This limits very much the potential to assess the condition and the trajectories of change in Mediterranean habitats
- Ocean warming, acidification, extreme climate events and biological invasions are expected to increase in the next years. These are difficult to be assessed and managed. More attention should be directed to those threats that can be more easily mitigated such as trawling, maritime traffic and nutrient loading from some land-based activities. In this framework, improve knowledge of the distribution and intensity of threats (e.g. fishery, bioinvasions, marine litter, seabed mining, coastal and non coastal infrastructures) to reduce uncertainties on their effects should be also increased.
- Promote open access to data is very critical, especially those deriving from EU projects, through institutional databases sustained under rules and protocols endorsed by EU. The data ensuing from EU projects are still much fragmented and are not stored in a single repository where data are available in a standard format with a stated access protocol.
- The process of Maritime Spatial Planning (MSP) across the Mediterranean should be largely supported, considering activities that are expected to increase in the future (e.g. aquaculture, maritime traffic, seabed mining).

2. Common Indicator 3: Species distributional range (marine mammals) (EO 1)

Background and rationale for the indicator, key pressures and drivers

The aim of this indicator is to provide information about the geographical area where marine mammal species occur, and to determine the range of cetaceans and seals that are present in the Mediterranean waters. The distribution of a given marine mammal species is usually described by a map, describing the species presence, distribution and occurrence. Geographical Information Systems (GIS) are commonly used to graphically represent monitoring data and species distributional range maps.

Data on distribution of marine mammals are usually collected during dedicated ship and aerial surveys, acoustic surveys, or opportunistically by whale watching operators, ferries, cruise ships, military ships.

Twelve species of marine mammals — one seal and 11 cetaceans — are regularly present in the Mediterranean Sea; all these 12 species belong to populations (or sub-populations, *sensu* IUCN) that are genetically distinct from their North Atlantic conspecifics. The Mediterranean monk seal (*Monachus monachus*) and the 11 cetacean species (fin whale, *Balaenoptera physalus*; sperm whale, *Physeter macrocephalus*; Cuvier's beaked whale, *Ziphius cavi*rostris; short-beaked common dolphin, *Delphinus delphis*; long-finned pilot whale, *Globicephala melas*; Risso's dolphin, *Grampus griseus*; killerwhale, *Orcinus orca*; striped dolphin, *Stenella coeruleoalba*; rough-toothed dolphin, *Steno bredanensis*; common bottlenose dolphin, *Tursiops truncatus*; harbour porpoise, *Phocoena phocoena relicta*) face several threats, due to heavy anthropogenic pressures throughout the entire Mediterranean basin.

The conservation status of marine mammals in the region is jeopardised by numerous human impacts, such as: (1) deliberate killing (mainly due to interactions with fisheries), naval sonar, ship strikes, epizootics, fisheries bycatch, chemical pollution and ingestion of solid debris; (2) short-term habitat displacement as a consequence of naval exercises using sonars, seismic surveys, vessel disturbance and noise; and (3) long-term relocation caused by food depletion due to over fishing, coastal development and possibly climate change.

Two of these species have very limited ranges: the harbour porpoise, possibly representing a small remnant population in the Aegean Sea, and the killer whale, present only as a small population of a few individuals in the Strait of Gibraltar.

Out of the 12 marine mammal species listed above, seven are listed under a Threat category on the IUCN's Red List, three are listed as Data Deficient and two need to be assessed.

Policy Context and Targets

The Mediterranean cetaceans' populations are protected under the framework of ACCOBAMS (Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area), under the auspices of the UNEP Convention on the Conservation of Migratory Species of Wild Animals (UNEP/CMS). The Pelagos Sanctuary is a large marine protected area, established by France, Italy and Monaco in the Corso-Ligurian-Provençal Basin and the Tyrrhenian Sea, where most cetacean species are regularly observed and benefit from its conservation regime.

All cetacean species in the Mediterranean Sea are also protected under the Annex II of the SPA-BD Protocol of the Barcelona Convention; under the Appendix I of the Bern Convention; under the Annex II of the Washington Convention (CITES); and under the Appendix II of the Bonn Convention (CMS).

The short-beaked common dolphin, the sperm whale and the Cuvier's beaked whale and the monk seal are also listed under the Appendix I of the Bonn Convention (CMS). The common bottle dolphin, the harbor porpoise and the monk seal are also listed under the Annex II of the EU Habitats Directive.

Results of the assessment

Mediterranean monk seal – Regularly present only in the Ionian, Aegean and Levantine Seas, the Mediterranean monk seas breeds in Greece and parts of Turkey and Cyprus. Deliberate killing, habitat loss and degradation, disturbance and potentially by-catch in fishing gear are the main threats.

Fin whale – This species is observed throughout the Mediterranean Sea, mainly in the western Basin. True Mediterranean fin whales range from the Balearic Islands to the Ionian and southern Adriatic seas, while North East North Atlantic (NENA) whales seasonally enter through the Strait of Gibraltar (Fig. 1). The main anthropogenic threats include collisions with ships, disturbance, chemical and acoustical pollution.

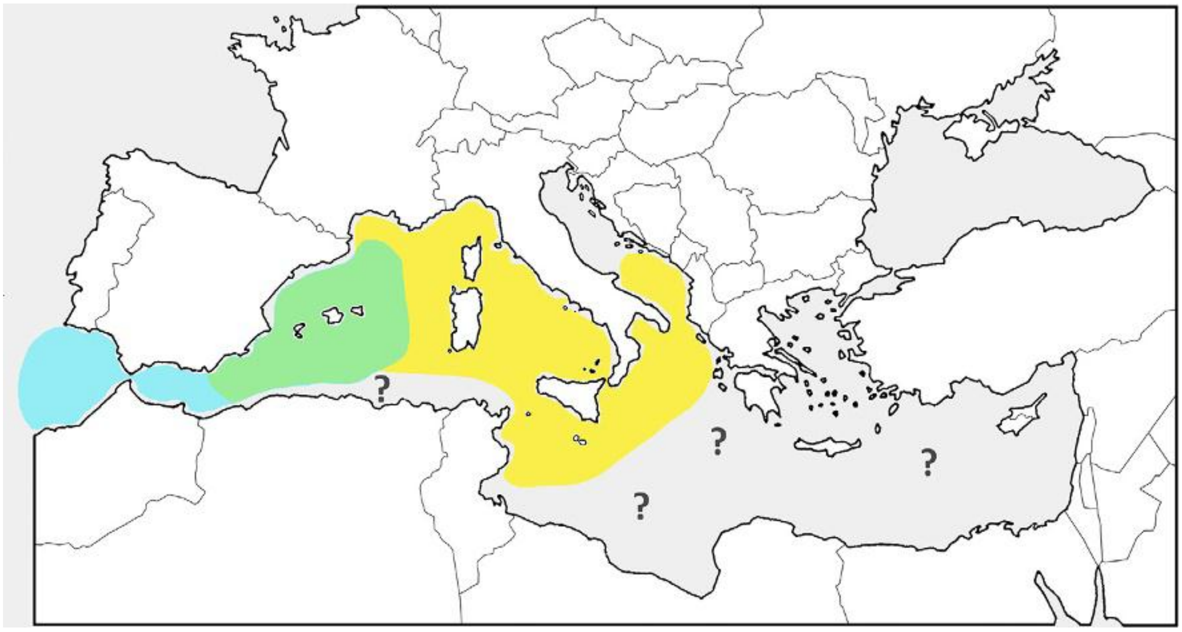

Fig. 1 - Presumed distribution of fin whale (Balaenoptera physalus) populations in the Mediterranean Sea. Blue: north-east North Atlantic population (NENA whales). Yellow: Mediterranean population (MED whales). In green the presumed overlap between the two populations (from: Notarbartolo di Sciara, G., Castellote, M., Druon , J.N., Panigada, S. 2016. Fin whales: at home in a changing Mediterranean Sea? Advances in Marine Biology Series, 75:75-101).

Sperm whale – Sperm whales prefer slope and deep waters all over the Basin, with localized hot spots in the Hellenic Trench, the Ligurian Sea, the Balearic area and the Gibraltar Strait. Human threats include ship strikes, occasional entanglement in driftnets, ingestion of plastic debris, anthropogenic noise and chemical contaminants.
Cuvier's beaked whale – This species is distributed throughout the Mediterranean Sea, mainly along the deep continental slope, in presence of underwater canyons. Cuvier's beaked whales are particularly vulnerable to military and industrial sonars, bycatch in fishing gears, ingestion of plastics.

Short-beaked common dolphin – Common dolphins significantly declined in the Mediterranean Sea over the last few decades and are now present in specific locations within the Alborán Sea, the Sardinian Sea, the Strait of Sicily, the eastern Ionian Sea, the Aegean Sea and the Levantine Sea. Prey depletion from overfishing and incidental mortality in fishing gear seem to be the main current threats for this species in the Mediterranean Sea.
Long-finned pilot whale – This species in present only in the western Basin only, mainly in offshore waters. Current threats include bycatch in driftnets, ship strikes, disturbance from military sonar and chemical pollution.
Risso's dolphin – Risso's dolphins are present – in relatively low numbers – throughout the Mediterranean Sea, with a preference for slope waters. Known distributional range includes the Alborán, Ligurian, Tyrrhenian, Adriatic, Ionian, Aegean and Levantine seas and the Strait of Sicily.
Killer whale – This species is seasonally present in the Strait of Gibraltar and adjacent Atlantic waters only and it is very rare in the rest of the Mediterranean Sea. Strong negative interactions with local artisanal bluefin tuna fisheries have been described.
Striped dolphin – The most common cetacean species in the Mediterranean Sea, mainly using offshore deep waters, from the Levantine Basin to the Strait of Gibraltar. Subject to a wide range Different threats affect the Mediterranean population, such as morbillivirus epizootics and high levels of chemical pollutants.
Rough-toothed dolphin – It is regular in the eastern Mediterranean only, particularly in the Levantine Sea, at very low densities and limited range. Subject to similar human impacts as other dolphins, including bycatch, acoustic and chemical pollution.

Common bottlenose dolphin – This is the most common species all over the Mediterranean Sea, mainly found on the continental shelf. Human threats include mortality in fishing gear, occasional direct killings, habitat loss or degradation including coastal development, overfishing of prey and high levels of contamination.

Harbour porpoise – This cetacean subspecies, typically found in the Black Sea, is occasionally observed in the northern Aegean Sea. Main threats in the Black Sea include severe levels of bycatch in fishing gears, mortality events and habitat degradation.

Conclusions and identification of gaps

Current knowledge about the presence, distribution, habitat use and preferences of Mediterranean marine mammals is limited and regionally biased, due to an unbalanced distribution of research effort during the last decades, mainly focused on specific areas of the Basin. Throughout the Mediterranean Sea, the areas with less information and data on presence, distribution and occurrence of marine mammals are the south-eastern portion of the basin, including the Levantine basin, and the North Africa coasts. In addition, the summer months are the most representative ones and very few information have been provided for the winter months, when conditions to conduct off-shore research campaigns are particularly hard due to meteorological adversity.

Marine mammals presence and distribution is mainly related to suitable habitats and availability of food resources; anthropogenic pressures, as well as climate change, may cause changes and shifts in the occurrence of marine mammals, with potential detrimental effects at the population levels. Accordingly, in order to enhance conservation effort and inform management purposes, it is crucial to obtain detailed and robust descriptions of species' range, movements and extent of geographical distribution, together with detailed information on the location of breeding and feeding areas.

Ongoing effort by ACCOBAMS is planning a synoptic region-wide survey, the so-called ACCOBAMS Survey Initiative, to assess presence and distribution and to estimate density and abundance of cetaceans in the summer of 2018. Concurrently, local scientists are working on the identification of Cetacean Critical Habitats (CCHs) and Important Marine Mammal Areas (IMMAs) in the entire Mediterranean Sea. A gap analysis is also been conducted within the Mediterranean Sea, to provide an inventory of available data and to select areas where more information should be collected.

3. Common indicator 3: Species distributional range (marine turtles) (EO 1)

3.1. Background and rationale for the indicator, key pressures and drivers

Background and rationale

In biology, the range of a given species is the geographical area in which that occurs (i.e. the maximum extent). A commonly used visual representation of the total areal extent (i.e. the range) of a species is a range map (with dispersion being shown by variation in local population densities within that range). Species distribution is represented by the spatial arrangement of individuals of a given species within a geographical area. Therefore, the objective of this indicator is to determine the species range of sea turtles that are present in Mediterranean waters, especially the species selected by the Parties.

Sea turtles are an ideal model species to assess the selected indicator, as their populations are dispersed throughout the entire Mediterranean, as discrete breeding, foraging, wintering and developmental habitats (Casale & Margaritoulis 2010), making the two sea turtle species a reliable indicator on the status of biodiversity across this region. Three sea turtle species are found in the Mediterranean (leatherback, *Dermochelys coriacea*; green, *Chelonia mydas*; and loggerhead, *Caretta caretta*), but only green and loggerhead turtles breed in the basin and have limited gene flow with those from the Atlantic, even though, turtles from the Atlantic do enter the western part of the basin (confirmed by genetic analyses: Encalada et al. 1998; Laurent et al. 1998). Green turtles are primarily herbivores, whereas loggerheads are primarily omnivores, resulting in their occupying important components of the food chain; thus, changes to the status in sea turtles, will be reflected at all levels of the food chain. However, the extent of knowledge on the occurrence, distribution, abundance and conservation status of Mediterranean marine species is uneven. In general, the Mediterranean states have lists of species, but knowledge about the locations used by these species is not always complete, with major gaps existing (Groombridge 1990; Margaritoulis et al. 2003; Casale & Margaritoulis 2010; Mazaris et al. 2014; Demography Working Group 2015). Even some of the most important programmes on this topic have significant gaps (e.g. Global databases do not reflect actual current knowledge in the Mediterranean region). It is therefore necessary to establish minimum information standards to reflect the known distribution of the two selected species. Species distribution ranges can be gauged at local (i.e. within a small area like a national park) or regional (i.e. across the entire Mediterranean basin) scales using a variety of approaches.

Given the breadth of the Mediterranean, it is not feasible to obtain adequate information about the entire surface (plus, the marine environment is 3 dimensional, with sea turtles being present only briefly to breathe), so it is necessary to choose sampling methods that allow adequate knowledge of the distribution range of each species. Such sampling involves high effort for areas that have not been fully surveyed to date. Monitoring effort should be long term and should cover all seasons to ensure that the information obtained is as complete as possible.

Key pressures and drivers

Both nesting and foraging areas of marine turtles are vulnerable to anthropogenic pressures in the Mediterranean Sea, including an increase in the exploitation of resources (including fisheries), use and degradation of habitats (including coastal development), pollution and climate change (UNEP/MAP/BLUE PLAN, 2009; Mazaris et al. 2009, 2014; Witt et al. 2011; Katselidis et al. 2012, 2013, 2014). These issues might reduce the resilience of this group of species, negatively impacting the ability of populations to recover (e.g. Mazaris et al. 2009, 2014; Witt et al. 2011; Katselidis et al. 2012, 2013, 2014). The risk of extinction is particularly high in the Mediterranean because the breeding populations of both loggerhead and green turtles in this basin are demographically distinct to other global populations (Laurent et al., 1998; Encalada et al., 1998), and might not be replenished.

The main threats to the survival of loggerhead and green turtles in the Mediterranean have been identified as incidental catch in fishing gear, collision with boats, and intentional killing (Casale & Margaritoulis 2010). Casale (2011) estimated that there are more than 132,000 incidental captures per year in the Mediterranean, of which more than 44,000 are predicted to be fatal, although very little is known about post-release mortality (Álvarez de Quevedo et al. 2013). Wallace et al. (2010, 2011) grouped all species of sea turtles globally into regional management units (RMUs), which are geographically distinct population segments, to determine the population status and threat level. These regional population units are used to assimilate biogeographical information (i.e. genetics, distribution, movement, demography) of sea turtle nesting sites, providing a spatial basis for assessing management challenges. A total of 58 RMUs were originally delineated for the seven sea turtle species. The Mediterranean contains 2 RMUs for loggerheads and 1 RMU for green turtles (Figure 1). These analyses showed that the Mediterranean has the highest average threats score out of all ocean basins, particularly for marine turtle bycatch (Wallace et al. 2011). However, compared to all RMUs globally, the Mediterranean also has the lowest average risk score (Wallace et al. 2011).

Other key threats to sea turtles in the Mediterranean include the destruction of nesting habitat for tourism and agriculture, beach erosion and pollution, direct exploitation, nest predation and climate change (Casale & Margaritoulis 2010; Mazaris et al. 2014; Katselidis et al. 2012, 2013 2014). Coll et al. (2011) also identified critical areas of interaction between high biodiversity and threats for marine wildlife in the Mediterranean. Within this analysis, the authors delineated high risk areas to both species, with critical areas extending along most coasts, except the south to east coastline (from Tunisia to Turkey) (Figures 2-4).

3.2. Policy Context and Targets

Similar to the Ecosystem Approach, the EU adopted the European Union Marine Strategy Framework Directive (MSFD) on 17 June 2008, which includes Good Environment Status (GES) definitions, Descriptors, Criteria, Indicators and Targets. In the Mediterranean region, the MSFD applies to EU member states. The aim of the MSFD is to protect more effectively the marine environment across Europe. In order to achieve GES by 2020, each EU Member State is required to develop a strategy for its marine waters (Marine Strategy). In addition, because the Directive follows an adaptive management approach, the Marine Strategies must be kept up-to-date and reviewed every 6 years.

The MSFD includes Descriptor 1: Biodiversity: "The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions." Assessment is required at several ecological levels: ecosystems, habitats and species. Among selected species are marine turtles and within this framework, each Member State that is within a marine turtle range, has submitted GES criteria, indicators, targets and a program to monitor them.

The MSFD will be complementary to, and provide the overarching framework for, a number of other key Directives and legislation at the European level. Also it calls to regional cooperation meaning "cooperation and coordination of activities between Member States and, whenever possible, third countries sharing the same marine region or subregion, for the purpose of developing and implementing marine strategies" […] "thereby facilitating achievement of good environmental status in the marine region or subregion concerned". Commission Decision 2010/477/EU sets out the MSFD's criteria and methodological standards and under Descriptor 1 includes criteria "1.1.Species distribution" and indicators "Distributional range (1.1.1)", "Distributional pattern within the latter, where appropriate (1.1.2)", and "Area covered by the species (for sessile/benthic species) (1.1.3)". At a country scale, Greece, Italy, and Spain have selected targets for marine turtles (Breeding areas are included as an MSFD target in Greece); Cyprus and Slovenia mention marine turtles in their Initial assessment, but do not set targets (Milieu Ltd Consortium. 2014) See UNEP/MAP 2016 for more details.

3.3. Results of the assessment

Loggerhead sea turtles

Nesting sites

Over 100 sites around the Mediterranean have scattered to stable (i.e. every year) nesting (Halpin et al., 2009; Kot et al. 2013; SWOT, 2006a, 2006b, 2008, 2009, 2010, 2011, 2012). Most sites are located in the eastern and central basins of the Mediterranean (Figure 5). Sporadic to regular nesting has been recorded in Cyprus, Egypt, Greece, Israel, Italy, Lebanon, Libya, Malta, Syria, Tunisia and Turkey (Margaritoulis et al. 2003; Casale & Margaritoulis 2010). Surveys have been conducted for tracks in Algeria (last surveyed 1980s), Croatia (last surveyed 1990s), France (last surveyed 1990s), Morocco (last surveyed 1980s), Spain (last surveyed 1990s) (Margaritoulis et al. 2003; Casale & Margaritoulis 2010). Information on nesting has not been gathered for Albania, Montenegro, Monaco, Slovenia or Bosnia (Margaritoulis et al. 2003; Casale & Margaritoulis 2010). A recent IUCN analysissuggests that, when all Loggerhead nesting sites in the Mediterranean are considered together, the geographic distribution of loggerheads in the Mediterranean is broad, and is considered of Least Concern though conservation dependent, under current IUCN Red List criteria (Casale 2015).

Most nests are laid in Greece, Turkey, Cyprus and Libya (Margaritoulis 2003; Casale & Margaritoulis 2010; Almpanidou et al. 2016). An average of 7200 nests are made per year across all sites (Casale & Margaritoulis 2010), which are estimated to represent 2,280–2,787 females based on clutch frequency assumptions (Broderick et al. 2002). Greece and Turkey alone have more than 75% of the nesting in the Mediterranean; however, the smaller populations at other sites such as Libya and Cyprus are also of regional significance being at the edges of the species range (Demography Working Group, 2015). Of note, the beaches of the countries of North Africa have not been extensively surveyed, particularly Libya, so gaps on the numbers and distribution of nests still remain. Genetic analyses suggest low gene flow among groups of rookeries; thus, it is essential to preserve distinct genetic units (Carreras et al. 2006).

The number of nests held at different sites is not just dependent on climate, but other factors, like predation, sand type/structure etc. (Almpanidou et al. 2016). Thus, a recent study of all Mediterranean nesting sites showed that the climatic suitability of current stable sites will remain suitable in the future (Almpanidou et al. 2016). However, other factors may lead to the loss of these sites, such as sea level rise (e.g. Katselidis 2014). Furthermore, Almpanidou et al. (2016) showed that sites with sporadic nesting might be increasingly used, i.e. such sites might not be past sites that are infrequently used, but may reflect the exploratory nature of turtles to locate new alternative sites (Schofield et al. 2010a). Thus, it is worth ensuring that all current stable nesting sites are fully protected (with their use into the future being likely); however, it is also important to follow how the use of sporadic nesting sites changes over time, to detect new sites of importance in need of protection (Katselidis 2014; Almpanidou et al. 2016).

Foraging (adult and developmental) and wintering sites

Most research has been conducted on nesting beaches; consequently, detailed information about marine habitat use at developmental, foraging and wintering grounds is still missing (Figure 8). The way in which adult and newly hatched turtles disperse from breeding sites has been explored using a range of techniques in the Mediterranean, including genetics, stable isotope, satellite tracking, particle tracking and stable isotopes (e.g. Zbinden et al 2008, 2011; UNEP(DEPI)/MED. 2011; Schofield et al. 2013; Patel 2013; Luschi & Casale 2014; Casale & Patrizio 2014; Hays et al. 2014; Snape et al. 2016). These studies indicate that loggerheads probably forage throughout all oceanic and neritic marine areas of the west and east basins of the Mediterranean (Hays et al. 2014; Casale & Marianni 2014). Most satellite tracking studies have been conducted in Spain (of juvenile turtles), Italy (a mix of juvenile and adult turtles) and Greece (adult males and females) and Cyprus (adult females) (UNEP(DEPI)/MED. 2011; Casale & Patrizio 2014). Due to these biases, the results of tracking studies alone should be treated with caution.

Through combining studies using various techniques, loggerheads do not appea to be uniformly distributed (Clusa et al. 2014), with foraging in different sub basins affecting remigration rates, body size and fecundity (Zbinden et al. 2011; Cardona et al. 2014; Hays et al 2014). While most turtles that breed in the eastern basin tend to forage in the eastern and central areas, increasing numbers of satellite studies are showing that some individuals do disperse to and use the western basin too (Bentivegna 2002; Schofield et al. 2013; Patel 2013). The west Mediterranean primarily supports individuals from the Atlantic (Laurent et al. 1998; Carreras et al. 2006; Casale et al. 2008). Tracking studies of juvenile loggerheads in the western Mediterrnaean show that they are widely distributed throughout the entire region (UNEP(DEPI)/MED. 2011). As information on the distribution is not available on juvenile loggerheads in the central and east Mediterranean, it is likely that similarly ubiquitous distribution exists, but needs confirming (UNEP(DEPI)/MED. 2011).

The two most important neritic loggerhead foraging grounds for adults and juveniles appear to be the Adriatic Sea and the Tunisian Continental Shelf (including Gulf of Gabés) (Zbinden et al. 2010; Casale et al. 2012; Schofield et al. 2013; Snape et al. 2016). Important oceanic areas include the Alboran Sea, the Balearic Sea and different parts of the North African coasts, as well as the Sicily Channel. Large numbers of juvenile loggerheads have been documented in the south Adriatic too (Casale et al. 2010; Snape et al. 2016). Aerial and fishery bycatch data indicate that the highest density of turtles occur in the western basin Alboran Sea and Balearic islands, the Sicily Strait, the Ionian Sea, the north Adriatic, off Tunisia, Libya, Egypt and parts of the Aegean (Gómez de Segura et al. 2003, 2006; Cardona et al. 2005; Lauriano et al. 2011; Casale & Margaritoulis 2010). In Egypt, Bardawil Lake has been identified as an important foraging area for adult and juvenile loggerheads based on stranding records and tracking studies of turtles from Cyprus (Nada et al. 2013, Snape et al. 2016).

However, establishing the distribution of, even coastal, foraging sites has yet to be achieved. Certain sites, where high numbers of turtles of all size classes from different populations aggregate in confined areas, have been identified, such as Amvrakikos Bay, Greece (Rees & Margaritoulis 2008) and Drini Bay, Albania (White et al 2011). However, tracking studies also show that the foraging areas of individual turtles may extend from <10 km2 up to 1000 km2 in the open waters of the Adriatic and Gulf of Gabés (Schofield et al. 2013). Furthermore, knowledge of how foraging habitat differs between adult males and females, as well as how these sites overlap with juvenile developmental habitat remains limited across the various populations (Snape et al. in submission). Particle tracking has suggested that, within the Mediterranean, adults exhibit high fidelity to sites where they established use as juveniles (Hays et al. 2014).

Furthermore, various studies have shown that, while turtles exhibit high fidelity to certain sites (Schofield et al. 2010b), both juvenile and adult loggerheads use more than one foraging site (sometimes up to 5), spanning both neritic and oceanic sites, particularly in the Ionian and Adriatic (Casale et al. 2007, 2012; Schofield et al. 2013). Adults that forage in the Adriatic, tend to use sites seasonally, shifting to alternative sites in winter (Zbinden et al. 2011: Schofield et al. 2013), although some hibernate (Hoscheid et al. 2007). However, juveniles have also been documented shifting into the Adriatic in winter, suggesting that some sites may be used year-round by different components of loggerhead populations (Snape et al. in submission). The use of multiple sites and seasonal shifts in site use need to be documented to understand how different foraging, developmental and wintering sites are connected. In this way, groups of areas should be protected where connections are known to exist.

Green turtles

Nesting sites

Most green turtle nests (99%) are laid in Turkey, Cyprus and Syria, with the remainder being found in Lebanon, Israel and Egypt (Figure 6; Kasparek et al. 2001; Casale & Margaritoulis 2010). An average of 1500 nests are documented each year (range 350 to 1750 nests), from which an annual nesting population of around 339–360 females has been estimated (Broderick et al. 2002), ranging from 115 to 580 females (Kasparek et al. 2001). The five key nesting beaches include: Akyatan, Samadağ, Kazanli (Turkey), Latakia (Syria) and Alagadi (northern Cyprus), with Ronnas Bay also being a priority area (Stokes et al. 2015). This allows the conservation effort of the nesting beaches for this species to be highly focused.

Foraging (adult and developmental) and wintering sites

As with loggerheads, most information about green turtles is restricted to the nesting habitats, rather than developmental, foraging, and wintering habitats. Green turtles have been primarily documented foraging and wintering along the Levantine basin (Figure 8 and Table 1; Turkey, Syria, Cyprus, Lebanon, Israel, Egypt) (Broderick et al. 2007; Stokes et al. 2015). However, foraging areas have also been documented in Greece (particularly, Lakonikos Bay and Amvrakikos Bay; Margaritoulis & Teneketzis 2003) and along the north coast of Africa, primarily Libya and some sites in Tunisia (see Figure 8 and Table for published sources). Some turtles have been documented in the Adriatic Sea (Lazar et al. 2004) and around Italian waters (Bentivegna et al. 2011), with some records occurring in the western basin (see Figure 8 and Table for published sources). In addition, Broderick et al (2007) detected wintering behaviour for greens off of Libya, with high fidelity to the same sites across years; however, further documentation has not been recorded for the other populations or other areas of the Mediterranean. These wintering sites were detected based on a shift in location to deeper water from early November to March/April and reduced area use compared to summer months, which were assumed to be indicative of reduced activity during the colder months. Lakonikos Bay in Greece and Chrysochou Bay in southern Cyprus represent well documented foraging grounds of juvenile green turtles based on strandings and bycatch databases. Within Egypt, Bardawill Lake has been identified as an important foraging area for adult and juvenile green turtles based on stranding records and tracking studies of turtles from Cyprus (Nada et al. 2013). In Turkey, green turtles have been documented stranded in the Gulf of Iskenderun, and might represent foraging habitat, while juvenile green turtles have been confirmed inhabiting the coast along the Cukurova, with Samandag and Fethiye Bay also representing possible juvenile foraging grounds (see Casale & Margaritoulis 2010 for overview). Overall, the way in which the foraging grounds are distributed and the numbers and size classes that they support, or how frequently green turtles move among sites (i.e. connectivity), remains limited.

3.4. Conclusions and identification of gaps

Due to the importance of both breeding and foraging grounds, parallel mitigation strategies are required to build the resilience of existing populations; such as regulating coastal development at nesting areas and fishery bycatch at foraging areas. However, foraging grounds tend to be broadly dispersed over a range of 0 to 2000 km from the breeding areas, complicating the identification of key foraging grounds for protection. As a starting point, it is essential to assimilate all research material on sea turtles (e.g. satellite tracking, stable isotope, genetic, strandings aerial surveys) to make a comprehensive overview of the distribution of different species, populations and size classes (Figure 7, represents a starting point).

Nesting sites

In general, knowledge about currently used nesting sites of both loggerhead and green turtles in the Mediterranean is good. However, all potential nesting beaches need to be surveyed throughout the Mediterranean to fill gaps in current knowledge (e.g. nesting in north Africa, particularly Libya). This could be done via traditional survey methods, but also by aerial surveys (plane or drone) at the peak period of nesting (July), or even by high resolution satellite imagery, which is becoming commercially available.

Existing stable nesting beaches should be afforded full protection, in parallel to collecting key information on why turtles use them, including geographic location, beach structure, sand composition, sand temperature ranges, coastal sea temperatures etc. In parallel, sporadically used beaches should be monitored at regular intervals (i.e. every 5 years or so), to identify changes in use over time, and pinpoint sites where use changes from sporadic to stable. Again, all these sites should be assessed with respect to geographic location, beach structure, sand composition, sand temperature ranges, coastal sea temperatures etc. on the ground, which will help with identifying future viable beaches for nesting. Ideally, all sandy beaches, whether used or not should be subject to the same analyses, to identify any beaches that might be used in the future by turtles, due to range shifts under climate change, which will alter sand temperatures on beaches and in the water, as well as causing sea level rise, which will alter the viability of current beaches, forcing turtles to shift to alternative sites. In this way, future beaches of importance can be detected and protected from certain human activities.

Foraging (adult and developmental) and wintering sites

It is necessary to determine how to focus protection effort of foraging (adult and developmental) habitats, i.e.

Protect easy-to-define areas where high numbers of turtles aggregate from different populations and size classes

Protect protracted areas of coastline where 10-20 individuals may aggregate at intervals from different populations and size classes, but amounting to representative numbers over a large expanse.

The former is easier to design and protect, but the latter may be more representative of sea turtle habitat use in the Mediterranean. The latter is more at risk of loss too, as management studies for the development of e.g. marinas and hotels would assume that the presence of just 10-20 turtles was insignificant; however, if this action was repeated independently across multiple sites, one or more turtle populations could become impacted.

Thus, it is essential to determine how developmental, foraging and wintering grounds are distributed throughout the Mediterranean, as well as the numbers of turtles of different size classes and from different populations that frequent these sites, including the seasonality of use and connectivity across sites. Only with this information can we make informed decisions about which sites/coastal tracts to protect that incorporate the greatest size class and genetic diversity.

Thus, aerial (plane or drone) surveys are recommended to delineate areas used by sea turtles in marine coastal areas, along with seasonal changes in use, by monitoring these sites at 2-4 month intervals. Following this initial assessment, representative sites should be selected and sampled on the ground (i.e. boat based surveys) to delineate species, size classes and collect genetic samples to determine the extent of population mixing. Where possible, stable isotope and tracking studies should be conducted (including PIT tagging) to establish the connectivity among sites.

Summary list of gaps

- Location of all breeding/nesting sites
- Location of all wintering, feeding, developmental sites of adult males, females, juveniles
- Connectivity among the various sites in the Mediterranean
- Vulnerability/resilience of these sites in relation to physical pressures
- Analysis of pressure/impact relationships for these sites and definition of qualitative GES
- Identification of extent (area) baselines for each site and the habitats they encompass
- Appropriate assessment scales
- Monitor and assess the impacts of climate change
- Assimilation of all research material on sea turtles (e.g. satellite tracking, stable isotope, genetic, strandings aerial surveys) in a single database

4. Common Indicator 3: Species distributional range (Sea birds) (EO 1)

4.1. Background and rationale for the indicator, key pressures and drivers

Understanding the distribution range of a species is the first step to assess its status and potential changes over time. It is also the simplest indicator, but that does not mean that reliable information is available for the whole region.

Overall, Mediterranean seabirds have reduced their distribution range across historical times, although there are few reliable sources of data to make a proper assessment of trends. The following factors are considered the main responsible for the changes in distribution range:

- The introduction of terrestrial predators in islands has likely shaped the current distribution of many seabirds, particularly the shearwaters and the storm-petrel, restricting them to inaccessible areas of the main islands and to remote islets. Even so, in many cases these seabirds coexist with terrestrial predators (Ruffino et al. 2009), often resulting in population declining trends.
- Human development has led to the degradation and destruction of coastal habitats across the Mediterranean basin. Birds breeding in wetlands have been likely the most affected, due to the systematic drying of these habitats. Likewise, birds breeding in beaches and dunes have also experienced a severe decline of available habitat in good condition and free of disturbances, particularly with the boom of tourism in the last century. The latter are more acute in the northern side of the region, but the whole basin is affected.
- Human persecution and harvesting. This is a threat that has been largely reduced in the last century, particularly in the north, but might have been a major source of change in past centuries, and can be still a threat in some areas.

Other relevant pressures to consider are overfishing and climate change, but these might have a major influence on the distribution patterns of seabirds at sea, while their role at shaping breeding distributions is not clear within the Mediterranean region. Species with limited foraging ranges, such as the Mediterranean shag and the terns are the most prone to suffer from these alterations, as they cannot buffer the effects of local alterations of their (breeding) foraging grounds by switching to other (more distant) areas. On this regard, terns (and Audouin's gull) are adapted to cope with fluctuations on prey availability by changing their breeding location between years, if necessary.

Even if there are no proven changes in seabirds breeding distribution ranges due to food depletion and/or climate change (or, more widely, environmental change), they are likely to occur in the near future if the levels of fish overexploitation and environment degradation are maintained through time. Nevertheless, lacks of accurate data make it difficult to assess this type of changes, and it is necessary to set in place adequate monitoring programmes across the basin to make possible a proper assessment in the future.

4.2. Policy Context and Targets

Processes driving changes in distribution range can work both at local and regional level. For a local level approach, the protection of breeding sites is a first step to ensure the maintenance of the breeding range of seabirds. However, it is important to complement these efforts on land with the protection of the corresponding key habitats at sea. On this regard, the Mediterranean is in the process of building a representative and coherent network of Marine Protected Areas (e.g. Gabrié *et al*. 2012), that under proper management strategies will surely benefit the maintenance of the remaining seabird breeding populations, plus other visiting species. Moreover, promoting the protection of former/potential breeding sites, or even their restoration, could help recovering part of the lost distribution range for some species, through re-colonisation processes.

However, local measures might not suffice to fight pressures at sub-regional, regional or global level. Ensuring a healthy marine ecosystem requires sectorial policies adopting an ecosystem-based approach. Fisheries deserve particular attention, given the level of overexploitation of Mediterranean fish stocks. Current commitments by the General Fisheries Commission for the Mediterranean are a promising perspective, as well as the efforts of the EU Common Fisheries Policy in the European countries, but there is a long way ahead. Other issues to address are pollution (UNEP/MAP 2015), river discharges (to ensure marine productivity), and climate/environmental change, which require an even wider approach (UNEP/MAP 2016).

4.3. Results of the assessment

A summary of the presence/absence of the species selected for monitoring is shown in Table 1, per sub-region and country. As with other biodiversity components, seabirds show a higher diversity to the west and north of the Mediterranean basin (cf. Coll et al. 2008). This general pattern is in agreement with the marine productivity patterns in the region, but might also be related to other factors, such as better knowledge/monitoring programmes in the north and west. Species that breed in open nests, such as gulls and terns, seem to be more widely distributed, particularly the little tern. On the other hand, burrowing/crevice breeding species such as the shearwaters tend to concentrate in the north and west. These species might find more suitable habitat in these areas, but also the difficulty of finding their nests and their secretive behaviour near the colonies might have left them overlooked in some low-prospected areas.

Table: Presence of the different seabird species selected for monitoring per sub-region and country. Orange represents breeding, and blue non-breeding (mainly winter, but this can also reflect the presence of birds during the breeding season and/or migration in countries where they do not breed). Dark colour is for regular and well established species, while light colour is for scarce species. Question marks are introduced when the information deserves further corroboration or refinement.

Sub-regions		P. mauretanicus		P. yelkouan		Ph. aristotelis d.		L. audouinii		S. sandvicensis		S. albifrons		S. nilotica	
	Countries	Br.	Non-br.	Br.	Non-br.	Br.	Non-br.	Br.	Non-br.	Br.	Non-br.	Br.	Non-br.	Br.	Non-br.
Western Mediterranean	Algeria			(?)				(?)				(?)			
	France								(?)						
	Monaco					?					(?)		(?)		
	Morocco														
	Spain														
Central Mediterranean & Ionian	Libya				(?)						(?)		(?)		
	Malta										(?)		(?)		
	Tunisia		?				(?)				(?)		(?)		
	Italy										(?)				
	Greece			(?)					(?)				(?)		
Adriatic Sea	Albania			(?)	(?)		(?)		(?)		(?)				
	Bosnia-Herzegovina				(?)	?	(?)		(?)		(?)		(?)		
	Croatia				(?)				(?)		(?)				
	Italy														
	Montenegro			?	(?)	?	(?)		(?)		(?)		(?)		
	Slovenia					?			(?)						
Eastern Mediterranean	Cyprus				(?)		(?)	(?)			(?)		(?)		
	Egypt				(?)	?	?		(?)		(?)		(?)		(?)
	Greece								(?)				(?)		
	Israel				(?)	?					(?)	(?)	(?)		
	Lebanon					?		(?)			(?)	(?)	(?)		
	Palestinian territories				(?)						(?)	(?)	(?)		
	Syria				(?)		(?)		(?)		(?)				
	Turkey					(?)	(?)	(?)	(?)		(?)		(?)		

4.4. Conclusions and identification of gaps

As insinuated above, the southeast to northwest increasing diversity gradient might be partly influenced by prospection/monitoring effort. For many eastern and southern countries, as well as some Adriatic countries, the information on seabird breeding populations or occurrence at sea is patchy or completely lacking. This might be partly because the birds are actually rare or absent there, but could also be related with lack of data. Particularly little information is available for Algeria, Egypt, Israel, Lebanon, Syria, Cyprus and Turkey, as well as Montenegro, and Albania. There is no information from Bosnia-Herzegovina, but this country has extremely limited coastal area, and most likely has no relevant seabird breeding populations. Information from Libya is also patchy, and focuses on terns.

The lack of information is not limited to the above countries, however. Most of the remaining countries have some important gaps, particularly at assessing population sizes, but also at properly inventorying all breeding colonies present in their territories, particularly in the case of the the shearwaters. For instance, a colony of over 1,500 Yelkouan shearwaters was recently found in Greece, near Athens, although this area is reasonably well prospected. Likewise, the breeding of the storm-petrel in the Aegean Sea was not confirmed until a few years ago.

5. Common indicator 4: Species population abundance (marine mammals) (EO 1)

5.1. Background and rationale for the indicator, key pressures and drivers

Population parameters such as abundance and density are essential components of the provision of science-based advice on conservation and management issues, both in terms of determining priorities for action and evaluating the success or otherwise of those actions. Such information is also often necessary to guarantee compliance with regulations at the national and international level.

By definition, population abundance refers to the total number of individuals of a selected species in a specific area in a given timeframe; while with density we refer to the number of animals per surface unit (e.g. number of animals per km^2). Monitoring density and abundance of cetaceans is particularly challenging and expensive. Cetaceans generally occur in low densities and are highly mobile; they are difficult to spot and to follow at sea, even during good survey conditions, because they typically only show part of their head, back and dorsal fin while surfacing and spend the majority of their time underwater.

In order to be able to assess potential trends over time, it is crucial to plan systematic monitoring programs, which are crucial components of any conservation strategy; unfortunately such approach is neglected in many regions, including much of the Mediterranean. Monitoring at the regional level may require data collection throughout the year, to better understand seasonal patterns in distribution, whereas monitoring at the population level would mainly address inter-annual changes.

Changes in density and abundance in time and space - known as population trends – are usually caused by anthropogenic pressures and/or natural fluctuations, environmental dynamics and climate changes. It is strongly suggested that marine mammals' abundance is monitored systematically at regular intervals to suggest and apply effective conservation measures and assess and review the efficacy of measures already in place.

This indicator aims at providing robust and quantitative indications on population abundance and density estimates for marine mammal species living in the Mediterranean Sea.

5.2. Policy Context and Targets

The Mediterranean cetaceans' populations are protected under the framework of ACCOBAMS (Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area), under the auspices of the UNEP Convention on the Conservation of Migratory Species of Wild Animals (UNEP/CMS). The Pelagos Sanctuary is a large marine protected area established by France, Italy and Monaco in the Corso-Ligurian-Provençal Basin and the Tyrrhenian Sea, where most cetacean species are regularly observed and benefit from its conservation regime.

All cetacean species in the Mediterranean Sea are also protected under the Annex II of the SPA-BD Protocol of the Barcelona Convention; under the Appendix I of the Bern Convention; under the Annex II of the Washington Convention (CITES); and under the Appendix II of the Bonn Convention (CMS).

The short-beaked common dolphin, the sperm whale and the Cuvier's beaked whale and the monk seal are also listed under the Appendix I of the Bonn Convention (CMS). The common bottle dolphin, the harbor porpoise and the monk seal are also listed under the Annex II of the EU Habitats Directive.

5.3. Results of the assessment

Mediterranean monk seal – Currently there are no population estimates for monk seals at the Mediterranean level; genetic analysis suggests that there may be two separate populations – genetically isolated – within the Basin, one in the Ionian Sea and one in the Aegean Sea. Previously listed as Critically Endangered by the IUCN Red List, the Mediterranean monk seal has been recently reassessed as Endangered, following an observed increase in individuals at localized breeding sites.

Fin whale – Comprehensive basin-wide estimates of density and abundance are lacking for all the species of cetaceans across the Mediterranean Region. Nonetheless, these parameters have been previously obtained for fin whales over large portions of the Central and Western Mediterranean Basin, highlighting seasonal, annual and geographical patterns. Line-transect surveys in 1991 yielded fin whale estimates in excess of 3,500 individuals over a large portion of the western Mediterranean

(Forcada et al., 1996), where most of the basin's fin whales are known to live. Panigada et al. (2011, in press) reviewed existing density and abundance estimates in the Central and Western parts of the Basin and reported on a series of aerial surveys conducted in the Pelagos Sanctuary and in the seas around Italy, providing evidence of declining numbers in density and abundance since the 1990's surveys. These recent estimates provided values of 330 fin whales in July 2010 in the Pelagos Sanctuary area. Panigada and colleagues also reported on density and abundance estimates on a wider area, including the Pelagos Sanctuary, the Central Tyrrhenian Sea and portion of the sea west of Sardinia, with an estimated abundance of 665 fin whales in summer 2010.

Sperm whale – There are no robust information on sperm whale population estimates for the entire Mediterranean Sea, while there are estimates obtained through photo-identification and line transect studies in localized specific areas. Given the values obtained in some Mediterranean areas (e.g. the Hellenic Trench, the Balearic islands, the Central Tyrrhenian Sea), it has been suggested that the entire population may be around a few hundred animals only, most likely under one thousand individuals.

Cuvier's beaked whale – No density and abundance estimates this species are available for the whole Mediterranean Sea. The only available robust sub-regional estimates come from line-transect surveys in the Alborán Sea and from photo-identification studies in the Ligurian Sea. The most recent corrected estimates number 429 individuals (CV=0.22) from the Alborán Sea and around 100 individuals (CV=0.10) in the Ligurian Sea. The lack of other estimates throughout the whole Mediterranean Sea precludes any inference on the numerical consistency of the entire population.

Short-beaked common dolphin – Common dolphins used to be very common in the Mediterranean Sea, and during the 20th century the species was subject to a large decline, drastically reducing its population levels. No population abundance estimates are available for the Mediterranean Sea, apart from localized areas, such as for example the Gulf of Corinth and the Alborán Sea, thus making it difficult to assess the entire population.

Long-finned pilot whale – Two populations have been described in the Mediterranean Sea, one living in the Strait of Gibraltar and one in the area between the Alborán and the Ligurian Seas. The Gibraltar population has been estimated at less than 250 individuals, while there are no estimated for the other population, which seems to be declining.

Risso's dolphin – There are no population estimates for Risso's dolphin in the whole Mediterranean Sea, with information coming only from localized areas. Distance sampling was used to estimate winter and summer abundance of Risso's dolphins in the north-western Mediterranean (N=2550 (95% CI: 849–7658) in winter and N=1783 (95% CI: 849–7658) in summer). Systematic photo-identification studies allowed to estimate, through mark-recapture methods, an average population of about 100 individuals (95% CI: 60–220) summering in the Ligurian Sea.

Killer whale – The most recent abundance estimate for this species is 39 individuals in 2011, representing one of the lowest levels compared to other killer whales population elsewhere in the world.

Striped dolphin – Comprehensive basin-wide estimates of density and abundance are lacking for this species across the Mediterranean Region; nonetheless, ship and aerial surveys have provided abundance and density values for striped dolphins over large portions of the Central and Western Mediterranean Basin, highlighting seasonal, annual and geographical patterns. The overall higher density, and hence abundance, observed in the North-Western Mediterranean Sea and estimated at 95,000 individuals (CV=0.11), with values clearly decreasing during the winter months and towards the Southern and Eastern sectors, reflects the general knowledge on the ecology of these species, described as the most abundant one in the Basin. Several estimates of abundance and density for this species have been provided for many areas of the Mediterranean, especially in the west, but no baseline data are available for the whole basin.

Rough-toothed dolphin – The very small number of authenticated records over the last 20 years (12 sightings and 11 strandings/bycatch) render any population estimate impossible and statistically unacceptable.

Common bottlenose dolphin – There are no density and abundance estimates for the entire Mediterranean Sea, with the only statistically robust estimates obtained from localized, regional research programmes in the Alborán Sea, the Balearic area, the Ligurian Sea, the Tunisian Plateau, the Northern Adriatic, the Western Greece and Israel in the Levantine Basin. The IUCN assessment for the Mediterranean population implies that less than 10,000 common bottlenose dolphins are present in the Basin.

Harbour porpoise – This cetacean is not regularly present in the Mediterranean Sea except in the Aegean Sea, where individuals from the Black Sea subspecies are occasionally observed and in the Alborán Sea, where individuals from the North Atlantic Ocean are rarely seen. No density and abundance estimates are available.

5.4. Conclusions and identification of gaps

The Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic area (ACCOBAMS) has been working for several years on defining an exhaustive program for estimating abundance of cetaceans and assessing their distribution and habitat preferences in the Black Sea, Mediterranean Sea and the adjacent waters of the Atlantic (the "ACCOBAMS Survey Initiative"). This initiative consists in a synoptic survey to be carried out in a short period of time across the whole Agreement area and it will combine visual survey methods (boat- and ship-based surveys) and passive acoustic monitoring (PAM).

Some of the cetaceans species present in the Mediterranean Sea are migratory species, whit habitat ranges extending over wide areas; it is therefore highly recommended to monitor these species at regional or sub-regional scales for the assessment of their population abundance. Priority should be given to the less known areas, using online data sources, such as Obis Sea Map and published data and reports as sources of information.

There is also general consensus among the scientific community that long-term systematic monitoring programmes, using techniques such as the photo-identification, provide robust and crucial data that can be used in assessing abundance at sub-regional levels and inform local conservation and mitigation measures. Establishing international collaborations between different research groups, merging existing data-sets allows to perform robust analysis and estimate population parameters at larger scales.

6. Common Indicator 4: Population abundance (marine turtles) (EO1)

6.1. Background and rationale for the indicator, key pressures and drivers

Background and rationale

Measurements of biological diversity are often used as indicators of ecosystem functioning, as several components of biological diversity define ecosystem functioning, including richness and variety, distribution and abundance. Abundance is a parameter of population demographics, and is critical for determining the growth or decline of a population. The objective of this indicator is to determine the population status of selected species by medium-long term monitoring to obtain population trends for these species. This objective requires a census to be conducted in breeding, migratory, wintering, developmental and feeding areas.

Effective conservation planning requires reliable data on wildlife population dynamics or demography (e.g. population size and growth, recruitment and mortality rates, reproductive success and longevity) to guide management effectively (Dulvy et al. 2003; Crick 2004). However, it is not possible to obtain such data for many species, especially in the marine environment, limiting our ability to infer and mitigate actual risks through targeted management. For sea turtles, nest numbers and/or counts of females are often used to infer population trends and associated extinction risk, because counts of individuals in the sea or when nesting on (often) remote beaches is tricky. Estimates of sea turtle abundance are obtained from foot patrols on nesting beaches counting either the number of females (usually during the peak 2-3 weeks of nesting) and/or their nests (Limpus 2005; Katselidis et al. 2013; Whiting et al. 2013, 2014; Pfaller et al. 2013; Hays et al. 2014). However, females may not be detected by foot patrols because they do not all initiate and end nesting at the same time and might not nest on the same beach or section of beach within or across seasons; consequently monitoring effort could fail to detect turtles or miss them altogether on unpatrolled beaches. Consequently, it is assumed that females lay two (Broderick et al. 2001), three (Zbinden et al. 2007;

Schofield et al 2013) or possibly as many as 5 or more clutches (Zbinden et al. 2007), depending on the beach being assessed in the Mediterranean. High environmental variability leads to overestimates of female population size in warmer years and under-estimates in cooler years (Hays et al. 2002). This is because sea turtles are ectotherms, with environmental conditions, such as sea temperature and forage resource availability, influencing the seasonality and timing of reproduction (Hays et al. 2002; Broderick et al. 2001, 2003; Fuentes et al. 2011; Schofield et al. 2009; Hamann et al. 2010; Limpus 2005). As a result, concerns have been raised about the reliability of using nest counts of females alone to infer sea turtle population trends (Pfaller et al 2013; Whiting et al. 2013, 2014).

Furthermore, nest counts cannot inform us about the number of adult males, the number of juveniles being recruited into the adult population, the longevity of nesting by individuals or mortality rates. Information is lacking on these components of sea turtle populations because males and juveniles remain in the water. Because turtles do not surface regularly, along with detection being difficult in low sea visibility of great sea depth conditions, a number of individuals are always missed from population surveys, requiring the use of certain statistical tools (such as distance sampling, Buckland et al. 1993) to be implemented to make up for the shortfall. Furthermore, for most populations the areas used by males and juveniles remain unknown (see Indicator 1). Yet, it is important to quantify the number of juveniles and males to guarantee successful recruitment into a population, as well as successful breeding activity to ensure population viability and health (i.e. genetic diversity, within Indicator 3) (Limpus 1993; Schofield et al. 2010; Demography Working Group 2015). This is because sea turtles exhibit temperature dependent sex determination, with the warming climate leading to heavily biased female production (Poloczanska et al., 2009; Katselidis et al. 2012; Saba et al., 2012). Therefore, we must quantify all of these parameters to understand sea turtle abundance trends and survival. Furthermore, factors impacting turtle population dynamics in the coming decades will not be detected from nest counts for another 30 to 50 years (Scott et al. 2011), because this is the generation time of this group and nest counts cannot predict how many juveniles are recruiting into the populations until they begin nesting themselves. This timeframe will likely be far too late to save many populations.

Gaps remain in assessing population abundance because it is not possible to survey all individuals in a turtle population either through in-water or beach-based surveys. It is therefore necessary to establish minimum information standards at key geographical sites to obtain reliable measures of population abundance of two selected species, taking into account all components of the population. To achieve this, first adequate knowledge about the distribution range of each species is required (Indicator 1). Monitoring effort should be long term and should cover all seasons to ensure that the information obtained is as complete as possible.

Key pressures and drivers

Both nesting and foraging areas of marine turtles are vulnerable to anthropogenic pressures in the Mediterranean Sea, including an increase in the exploitation of resources (including fisheries), use and degradation of habitats (including coastal development), pollution and climate change (UNEP/MAP/BLUE PLAN, 2009; Mazaris et al. 2009, 2014; Witt et al. 2011; Katselidis et al. 2012, 2013, 2014). These issues might reduce the resilience of this group of species, negatively impacting the ability of populations to recover (e.g. Mazaris et al. 2009, 2014; Witt et al. 2011; Katselidis et al. 2012, 2013, 2014). The risk of extinction is particularly high in the Mediterranean because the breeding populations of both loggerhead and green turtles in this basin are demographically distinct to other global populations (Laurent et al., 1998; Encalada et al., 1998), and might not be replenished.

The main threats to the survival of loggerhead and green turtles in the Mediterranean have been identified as incidental catch in fishing gear, collision with boats, and intentional killing (Casale & Margaritoulis 2010). Casale (2011) estimated that there are more than 132,000 incidental captures per year in the Mediterranean, of which more than 44,000 are predicted to be fatal, although very little is known about post-release mortality (Álvarez de Quevedo et al. 2013). Wallace et al. (2010, 2011) grouped all species of sea turtles globally into regional management units (RMUs), which are geographically distinct population segments, to determine the population status and threat level. These regional population units are used to assimilate biogeographical information (i.e. genetics, distribution, movement, demography) of sea turtle nesting sites, providing a spatial basis for assessing management challenges. A total of 58 RMUs were originally delineated for the seven sea turtle species. The Mediterranean contains 2 RMUs for loggerheads and 1 RMU for green turtles. These analyses showed that the Mediterranean has the highest average threats score out of all ocean basins, particularly for marine turtle bycatch (Wallace et al. 2011). However, compared to all RMUs globally, the Mediterranean also has the lowest average risk score (Wallace et al. 2011).

Other key threats to sea turtles in the Mediterranean include the destruction of nesting habitat for tourism and agriculture, beach erosion and pollution, direct exploitation, nest predation and climate change (Casale & Margaritoulis 2010; Mazaris et al. 2014; Katselidis et al. 2012, 2013, 2014). Coll et al. (2011) also identified critical areas of interaction between high biodiversity and threats for marine wildlife in the Mediterranean. Within this analysis, the authors delineated high risk areas to both species, with critical areas extending along most coasts, except the south to east coastline (from Tunisia to Turkey).

6.2. Policy Context and Targets

Similar to the Ecosystem Approach, the EU adopted the European Union Marine Strategy Framework Directive (MSFD) on 17 June 2008, which includes Good Environment Status (GES) definitions, Descriptors, Criteria, Indicators and Targets. In the Mediterranean region, the MSFD applies to EU member states. The aim of the MSFD is to protect more effectively the marine environment across Europe. In order to achieve GES by 2020, each EU Member State is required to develop a strategy for its marine waters (Marine Strategy). In addition, because the Directive follows an adaptive management approach, the Marine Strategies must be kept up-to-date and reviewed every 6 years.

The MSFD includes Descriptor 1: Biodiversity: “The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.” Assessment is required at several ecological levels: ecosystems, habitats and species. Among selected species are marine turtles and within this framework, each Member State that is within a marine turtle range, has submitted GES criteria, indicators, targets and a program to monitor them.

The MSFD will be complementary to, and provide the overarching framework for, a number of other key Directives and legislation at the European level. Also it calls to regional cooperation meaning “cooperation and coordination of activities between Member States and, whenever possible, third countries sharing the same marine region or subregion, for the purpose of developing and implementing marine strategies” […] “thereby facilitating achievement of good environmental status in the marine region or subregion concerned”. Commission Decision 2010/477/EU sets out the MSFD’s criteria and methodological standards and under Descriptor 1 includes criteria “1.1.Species distribution” and indicators “Distributional range (1.1.1)”, “Distributional pattern within the latter, where appropriate (1.1.2)”, and ”Area covered by the species (for sessile/benthic species) (1.1.3)”. At a country scale, Greece, Italy, Spain have selected targets for marine turtles; Cyprus and Slovenia mention marine turtles in their Initial assessment, but do not set targets (Milieu Ltd Consortium. 2014). Italy has an MSFD target to define the spatial distribution of loggerheads and their aggregation areas by assessing temporal and seasonal distribution differences for each aggregation area. Spain has an MSFD target to promote international cooperation on studies and monitoring of populations of groups with broad geographic distribution, contributing to a second target of maintaining positive or stable trends for the populations of key species, like marine turtles, and maintain commercially exploited species within safe biological limits. Obtaining census data on nesting beaches is included as an MSFD target in Greece. See UNEP/MAP 2016 for more details.

6.3. Results of the assessment

Loggerhead sea turtles

Adult females at breeding areas

Over 100 sites around the Mediterranean have scattered to stable (i.e. every year) nesting (Halpin et al., 2009; Kot et al. 2013; SWOT, 2006a, 2006b, 2008, 2009, 2010, 2011, 2012), of which just 13 sites support more than 100 nests each (Casale & Margaritoulis 2010). Greece and Turkey alone represent more than 75% of the nesting effort in the Mediterranean; for details on nest numbers at the different sites in the Mediterranean see Casale & Margaritoulis (2010) and Figure 1. An average of 7200 nests are made per year across all sites (Casale & Margaritoulis 2010), which are estimated to be made by 2,280–2,787 females assuming 2 or 3 clutches per female (Broderick et al. 2002).

A recent IUCN analysis (Casale 2015) suggests that, when all Loggerhead nesting sites in the Mediterranean are considered together, the Mediterranean population size is relatively large, and is considered of Least Concern but conservation dependent under current IUCN Red List criteria. However, refer back to limitations of population analyses in the Introductory section.

While tagging programs exist at some of the main nesting sites in the Mediterranean on nesting beaches, the loss of external flipper tags has proven problematic in maintaining long-term records of individuals (but see Stokes et al. 2014). However, these estimates of female numbers should be treated with caution because the Mediterranean represents one of the most temperate breeding regions of the world. Consequently, clutch frequency will vary from season to season depending on the prevailing weather conditions. For instance, in years with prevailing north winds, sea temperatures remain cooler, resulting in longer inter-nesting periods (Hays et al. 2002), and fewer clutches per individual, with the opposite trend being obtained in years with prevailing south winds. Even in tropical nesting sites, with relatively stable temperatures during breeding, clutch frequency can vary by as much as 3-12 clutches (Tucker 2010). Furthermore, the trophic status of foraging sites influences remigration frequency; thus, more turtles may return to breed in some years, again causing nest numbers to fluctuate (Broderick et al. 2001, 2002). Therefore, for programs that elucidate female numbers based on nest counts, the mean clutch frequency and breeding periodicity should be assessed at regular intervals by means of high resolution satellite tracking of individuals across years with different climatic conditions. Of note, knowledge about the numbers of females that nest on the beaches of the countries of North Africa remains limited and requires resolution.

Adult males at breeding areas

To date, no study globally has obtained an estimate of the number of males in a breeding population. This is because males remain in the marine area, making counts difficult to obtain. Within the Mediterranean, only Schofield et al. (2010) have attempted to estimate the numbers of males within a loggerhead rookery (Zakynthos) using photo-identification. Intensive capture-recapture over a three month period indicated a 1:3.5 ratio of males to females (based on a sample size of 154 individuals). Furthermore, Hays et al. (2014) showed that most males in this population breed annually (although some of those that forage off Tunisia/Libya and in western Greece return biannually; Hays et al. 2014; Casale et al. 2013), using a combination of long-term satellite tracking (over 1 year) and multi-year photo-identification records, with similar return rates being recorded in other populations globally (Limpus 1993). Based on this information, just 100 males might breed annually, with the same males breeding every year, in contrast to an estimated 600-800 females for this population (based on nest counts; Casale and Margaritoulis 2010). Therefore, it is imperative to ascertain the rate of recruitment and mortality of males in the population. If we assume 2,280–2,787 adult females loggerheads in the Mediterranean (Broderick et al. 2002), then there may be just 580 to 696 adult loggerhead males in total, with some populations potentially supporting very small numbers of males, especially when considering that Zakynthos is considered one of the largest breeding populations in the Mediterranean (Casale & Margaritoulis 2010; Katselidis et al. 2013; Almpanidou et al. 2016). Thus, counts of males across all breeding populations are required to ascertain the importance of protecting this component of sea turtle populations.

Developmental and adult foraging/wintering habitats

Because loggerheads probably forage throughout all oceanic and neritic marine areas of the west and east basins of the Mediterranean (Hays et al. 2014; Casale & Mariani 2014), combined with the fact that both adults and juveniles may frequent multiple habitats, counts of individuals in specific areas prove difficult.

Juvenile and immature turtles represent the greatest component of the population; thus information on the size structure and abundance at foraging grounds is essential to understand changes in nest counts, based on changes in mortality and recruitment into adult breeding populations (Demography Working Group, 2015). However, because the juveniles of each nesting population may be dispersed across multiple habitats, and appear to use different sites across seasons, obtaining such counts is difficult requiring the complementary use of genetic sampling (Casale & Margaritoulis 2010).

Aerial and fishery bycatch data provide some information on turtle abundance in the western basin Alboran Sea and Balearic islands, the Sicily Strait, the Ionian Sea, the north Adriatic, off Tunisia-Libya, Egypt and parts of the Aegean (Gómez de Segura et al. 2003, 2006; Cardona et al. 2005; Lauriano et al. 2011; Casale & Margaritoulis 2010; Fortuna et al. 2015), with unpublished information existing for the Balearic Sea, the Gulf of Lions, the Tyrrhenian Sea, the Ionian Sea, and the Adriatic Sea (Demography Working Group 2015). There are also bycatch data available providing evidence of turtle numbers (e.g. Casale & Margaritoulis 2010; Casale 2011, 2012). Another source of information is in-water capture at focal sites such as Amvrakikos, Greece (Rees et al. 2013) and Drini Bay, Albania (White et al. 2013). At Drini Bay, Albania, 476 turtles of size class 20 cm to 80 cm were captured primarily May to October (Casale & Margaritoulis 2010). Furthermore, long-term studies (2002-present) have shown the presence of large juvenile to adult loggerheads (46-92 cm) in Amvrakikos Bay, Greece (Rees et al. 2013).

Thus, the data from existing sites needs to be assimilated and assessed for representativeness in providing abundance information on juvenile and adult turtles, so as to determine how to focus effort effectively across foraging and developmental sites across the Mediterranean. In parallel, techniques to obtain counts on a regular basis across a wide range of habitats need to be developed.

Green turtles

Adult male and females in breeding habitats

Most green turtle nests (99%) are laid in Turkey, Cyprus and Syria, with the remainder being found in Lebanon, Israel and Egypt (Figure 2; Kasparek et al. 2001; Casale & Margaritoulis 2010). Out of 30 documented sites, just six host more than 100 nests per season (Stokes et al. 2014), with a maximum of just over 200 nests at two sites (both in Turkey). For details on nest numbers at the different sites in the Mediterranean see Stokes et al (2015) and Figure 2. An average of 1500 nests are documented each year (range 350 to 1750 nests), from which an annual nesting population of around 339–360 females has been estimated assuming two to three clutches (Broderick et al. 2002). Unlike loggerheads, green turtles globally strong exhibit interannual fluctuations in the number of nests, which has been associated with annual changes in forage resource availability (Broderick et al. 2001). Consequently, our knowledge about the population dynamics of green turtles in the Mediterranean remains insufficient.

Developmental and adult foraging/wintering habitats

Information about the numbers of green turtles in various developmental, foraging and wintering habitats is limited. While the greatest numbers of green turtles have been documented in the Levantine basin (Demography Working Group 2015), there are records of individuals using habitat in the Adriatic Sea (Lazar et al. 2004) and around Italian waters (Bentivegna et al. 2011), with some records occurring in the western basin; however, actual numbers, have not been obtained. It is essential to document the numbers of adults and juveniles that frequent developmental, foraging and wintering habitats in order to isolate key sites for management protection.

6.4. Conclusions and identification of gaps

Major gaps exist in estimating the population abundance of sea turtles. First, the use of nest counts as a proxy for female numbers must be treated with caution, and variation in climatic factors at the nesting site and trophic factors at foraging sites taken into account. Counts of males at breeding grounds must be incorporated into programs at nesting sites. If just a total of 100 males frequent Zakynthos, which has around 1000 nests/season, then most sites throughout the Mediterranean (of which most have <100 nests) are likely to support very low numbers of males, making the protection of these individuals essential. Finally, with the delineation of developmental, foraging and wintering habitats (Indicator 1), it will be necessary to obtain counts of the number of individuals, particularly juveniles, that frequent these various habitats seasonally and across years. While information on the number of juveniles alone at given habitats does not reflect on any given nesting population, the relative numbers of immature to mature animals will provide baseline information about key juvenile developmental habitats and actual numbers relative to those obtained to adults.

Overall, programs at nesting sites need to place a strong focus on ensuring long-term recognition of female individuals and incorporate counts of males. The realisation of Indicator 1, will help with delineating developmental, foraging and wintering sites to make counts of adult vs juvenile turtles and fluctuations in numbers over time. Information obtained through Indicator 2 will be intrinsically linked with Indicator 3 (see this section).

Summary list of gaps

- Seasonal and total numbers of adult females frequenting breeding sites
- Seasonal and total numbers of adult males frequenting breeding sites
- Numbers of adult males and females frequenting foraging and wintering sites, including seasonal variation in numbers
- Numbers of adult males and females frequenting foraging and wintering sites, including seasonal variation in numbers
- Vulnerability/resilience of documented populations and subpopulations in relation to physical and anthropogenic pressures;
- Analysis of pressure/impact relationships for these populations and subpopulations, and definition of qualitative GES;
- Identification of extent (area) baselines for each population and subpopulation with respect to adult females, adult males and juveniles to maintain the viability and health of these populations
- Appropriate assessment scales;
- Monitor and assess the impacts of climate change on nest numbers (clutch frequency) and breeding periodicity (remigration intervals) of females, as these paramaters are used as proxies for inferring female numbers.
- Monitor and assess the impacts of climate change on the breeding periodicity (remigration intervals) of males, as this provides an indication of total male numbers
- Assimilation of all research material on sea turtles (e.g. satellite tracking, stable isotope, genetic, strandings aerial surveys) in a single database

7. Common Indicator 4: Population abundance (sea birds) (EO1)

(To be determined)

8. Common Indicator 5: Population demographic characteristics (marine mammals) (EO 1)

Background and rationale for the indicator, key pressures and drivers

The objective of this indicator is to focus on the population demographic characteristics of marine mammals within the Mediterranean waters. Demographic characteristics of a given population may be used to assess its conservation status by analysing demographic parameters as the age structure, age at sexual maturity, sex ratio and rates of birth (fecundity) and of death (mortality). These data are particularly difficult to obtain for marine mammals, thus relying on demographic models, which imply several assumptions which may be violated.

The populations of long-lived and slow reproducing cetaceans are among the most critical conservation units; a demographic approach can be therefore very useful for their management and conservation.

While some demographic studies have been conducted using industrial whaling data on Northeast Atlantic populations, little is known about the demography of their counterparts in the Mediterranean, where industrial whaling has never occurred.

Policy Context and Targets

Results of the assessment

Fin whale - Demographic models - commonly used in animal and plant populations - have been applied to marine mammals and cetaceans only in the recent years. Usually, two different approaches are used when dealing with demographic studies, based on static or cohort life-tables. A third approach refers to the use of mortality tables and provides detailed information about size⁄age and sex of dead individuals. This approach, based on stranding data, has for the first time been applied to cetaceans in the Mediterranean Sea, developing a demographic model for the Mediterranean fin whale population based on a life-history table (mortality table) using stranding records. Dealing with stranded data implies several assumptions; the main one being that stranding data represent a faithful description of the real mortality by different life stages. This assumption, however, is true only if the probability of stranding is equal in all life stages.

This preliminary study described the structure of the Mediterranean sub-population by analyzing stranding records from the period 1986–2007, showing a strong impact, natural and anthropogenic, on calves and immature animals. These results, while confirm a common pattern to several mammals – characterized by high mortality in the youngest age classes - may prevent reaching sexual maturity, thus severely impacting the species at the population level. Proper conservation plans should therefore consider the discovery of breeding grounds, where calves may benefit from greater protection, to increase survival rates. Similarly, appropriate naval traffic regulations, aimed at reducing mortality rates from ship collisions, could enhance the survival of mature females and calves. In addition, mitigating other sources of mortality and stress, such as chemical and acoustic pollution, whale-watching activities and habitat loss and degradation, could further improve the population’s chances of survival.

Common bottlenose dolphin - The only Mediterranean area with quantitative historical information that can be used to infer population trends over time scales of more than a couple of decades is the northern Adriatic Sea. There, bottlenose dolphin numbers likely declined by at least 50% in the second half of the 20th century, largely as a consequence of deliberate killing initially, followed by habitat degradation and overfishing of prey species. For some other parts of the northern Mediterranean, e.g. Italy and southern France, the available information is less precise but suggests similar trends. In an area off southern Spain where the species has been studied intensively, abundance estimates have shown variability but no trend since the early 1990s.

Since there are no historical data on the density and abundance of bottlenose dolphins in the Pelagos Sanctuary, it is not possible to infer possible increase or decrease over time. The Groupe d’Etudes des Cétacés deMéditerranée has estimated – through direct counting and photo-identification - around 198–242 dolphins around the island of Corsica in 2000, and 130–173 in 2003. These estimates appear to be lower than those assessed through mark recapture analysis in the same area in 2006, but any inference on potential trends is purely speculative, as a different approach has been used to for these estimated and this may lead to significant biases.

Conclusions and identification of gaps

Monitoring effort should be directed to collect long-term data series covering the various life stages of the selected species. This would involve the participation of several teams using standard methodologies and covering sites of particular importance for the key life stages of the target species.

The preliminary classical tools for demographic analyses are life tables, accounting for the birth rates and probabilities of death for each vital stage or age class in the population. A life table can be set out in different ways:

1) following an initial age class (i.e. cohort) from birth to the death of the last individual; this approach allows to set out a cohort life table and is generally applied on sessile and short-lived populations;

2) counting population individuals grouped by age or by stages in a given time period; this approach allows to obtain a static life table, that is appropriate with long-lived or mobile species;

3) analysing the age or stage distribution of individuals at death; this approach allows to develop a mortality table, using carcasses from stranding data.

Photo-identification is one of the most powerful techniques to investigate cetacean populations. Information on group composition, area distribution, inter-individual behavior and short and long-term movement patterns can be obtained by the recognition of individual animals. Long-term datasets on photo-identified individuals can provide information on basic life-history traits, such as age at sexual maturity, calving interval, reproductive and total life span. Nevertheless, estimating age and length from free-ranging individuals may be rather difficult and increase the uncertainties in the models. Long-term data sets on known individuals through photo-identification may overcome some of the potential biases.

9. Common Indicator 5: Population demographic characteristics (marine turtles) (EO 1)

9.1 Background and rationale for the indicator, key pressures and drivers

Background and rationale

Effective conservation planning requires reliable data on wildlife population dynamics or demography (e.g. population size and growth, recruitment and mortality rates, reproductive success and longevity) to guide management effectively (Dulvy et al. 2003; Crick 2004). However, it is not possible to obtain such data for many species, especially in the marine environment, limiting our ability to infer and mitigate actual risks through targeted management. Yet, demographic information helps to identify the stage(s) in the life cycle that affect(s) most population growth, and may be applied to (1) quantify the effectiveness of conservation measures or extent of exploitation (e.g. fisheries management), (2) understand the evolution of life history traits and (3) indicate fitness with respect to the surrounding environment.

For sea turtle populations, some measures of demography are well documented, such as nest and/or female numbers (see Indicator 2), from which population trends are currently applied to infer population growth (or recovery) and, hence, threat status. Yet, without information about the number of juveniles recruiting into the population (e.g. Dutton et al. 2005; Stokes et al. 2014), or reliable estimates of mortality rates of both juveniles and adults, it is very difficult to predict future trends. For instance, factors impacting turtle population dynamics in the coming decades will not be detected from nest counts for another 30 to 50 years (Scott et al. 2011), because this is the generation time of this group and nest counts cannot predict how many juveniles are recruiting into the populations until they begin nesting themselves.

Another parameter that is well established is the emergence success rate of hatchlings from the nests, along with offspring sex ratios at hatching. Globally, highly female-biased offspring sex ratios have been predicted (Witt et al. 2010; Hays et al. 2014). This high female bias is of concern because sea turtles exhibit temperature dependent sex determination, with the warming climate ultimately leading to even more biased female production (Poloczanska et al., 2009; Saba et al., 2012; Katselidis et al. 2012). Thus, it is essential to determine how the offspring sex ratio transforms into the adult sex ratio, to determine the minimum number of males needed to keep a population viable and genetically healthy, which are not necessarily the same. Because males tend to breed more frequently than females (i.e. every 1-2 years versus 2 or more years by females; Casale et al. 2013; Hays et al. 2014), fewer males might be needed in the population to mate with all females. However, biased sex ratios can induce deleterious genetic effects within populations with a decline in the effective population size and increasing the odds of inbreeding and random genetic drift (Bowen & Karl 2007; Girondot et al. 2004; Mitchell et al. 2010). However, most sea turtle populations exhibit high multiple paternity (i.e. the eggs of individual females are fathered by multiple males; for review see Lee et al. in submission). This behaviour is considered to be a strategy to enhance genetic diversity; thus, if male numbers further declined, this could have deleterious effects on the population (Girondot et al. 2004). Furthermore, differences in survival between the sexes might occur in different age classes (Sprogis et al. 2016); thus, it is essential to quantify sex ratios and sex-specific mortality across the different size/age classes. Strandings provide a useful source of information on the causes of mortality, but do not necessarily reflect the actual numbers of animals that are dying (Epperly et al. 1996; Hart et al. 2006). Bycatch data have also been used to estimate mortality rates (for overview see, Casale 2011), which are predicted to be around 44000 turtles/year in the Mediterranean. However, these values need confirmation.

Consequently, these knowledge gaps hinder our ability to generate representative demographic models to provide accurate assessments of the conservation status of loggerhead and green turtles in the Mediterranean. Yet, such information is vital to implement the most appropriate measures to conserve sea turtles.

Key pressures and drivers

Both the nesting and foraging areas of marine turtles are vulnerable to anthropogenic pressures in the Mediterranean Sea, including an increase in the exploitation of resources (including fisheries), use and degradation of habitats (including coastal development), pollution and climate change (UNEP/MAP/BLUE PLAN, 2009; Mazaris et al. 2009, 2014; Witt et al. 2011; Katselidis et al. 2012, 2013, 2014). These issues might reduce the resilience of this group of species, negatively impacting the ability of populations to recover (e.g. Mazaris et al. 2009, 2014; Witt et al. 2011; Katselidis et al. 2012, 2013, 2014). The risk of extinction is particularly high in the Mediterranean because the breeding populations of both loggerhead and green turtles in this basin are demographically distinct to other global populations (Laurent et al., 1998; Encalada et al., 1998), and might not be replenished.

The main threats to the survival of loggerhead and green turtles in the Mediterranean have been identified as incidental catch in fishing gear, collision with boats, and intentional killing (Casale & Margaritoulis 2010). Casale (2011) estimated that there are more than 132,000 incidental captures per year in the Mediterranean, of which more than 44,000 are predicted to be fatal, although very little is known about post-release mortality (Álvarez de Quevedo et al. 2013). Wallace et al. (2010, 2011) grouped all species of sea turtles globally into regional management units (RMUs), which are geographically distinct population segments, to determine the population status and threat level. These regional population units are used to assimilate biogeographical information (i.e. genetics, distribution, movement, demography) of sea turtle nesting sites, providing a spatial basis for assessing management challenges. A total of 58 RMUs were originally delineated for the seven sea turtle species. The Mediterranean contains 2 RMUs for loggerheads and 1 RMU for green turtles. These analyses showed that the Mediterranean has the highest average threats score out of all ocean basins, particularly for marine turtle bycatch (Wallace et al. 2011). However, compared to all RMUs globally, the Mediterranean also has the lowest average risk score (Wallace et al. 2011).

Other key threats to sea turtles in the Mediterranean include the destruction of nesting habitat for tourism and agriculture, beach erosion and pollution, direct exploitation, nest predation and climate change (Casale & Margaritoulis 2010; Mazaris et al. 2014; Katselidis et al. 2012, 2013, 2014). Coll et al. (2011) also identified critical areas of interaction between high biodiversity and threats for marine wildlife in the Mediterranean. Within this analysis, the authors delineated high risk areas to both species, with critical areas extending along most coasts, except the south to east coastline (from Tunisia to Turkey).

9.2. Policy Context and Targets

Similar to the Ecosystem Approach, the EU adopted the European Union Marine Strategy Framework Directive (MSFD) on 17 June 2008, which includes Good Environment Status (GES) definitions, Descriptors, Criteria, Indicators and Targets. In the Mediterranean region, the MSFD applies to EU member states. The aim of the MSFD is to protect more effectively the marine environment across Europe. In order to achieve GES by 2020, each EU Member State is required to develop a strategy for its marine waters (Marine Strategy). In addition, because the Directive follows an adaptive management approach, the Marine Strategies must be kept up-to-date and reviewed every 6 years.

The MSFD includes Descriptor 1: Biodiversity: “The quality and occurrence of habitats and the distribution and abundance of species are in line with prevailing physiographic, geographic and climatic conditions.” Assessment is required at several ecological levels: ecosystems, habitats and species. Among selected species are marine turtles and within this framework, each Member State that is within a marine turtle range, has submitted GES criteria, indicators, targets and a program to monitor them.

The MSFD will be complementary to, and provide the overarching framework for, a number of other key Directives and legislation at the European level. Also it calls to regional cooperation meaning “cooperation and coordination of activities between Member States and, whenever possible, third countries sharing the same marine region or subregion, for the purpose of developing and implementing marine strategies” […] “thereby facilitating achievement of good environmental status in the marine region or subregion concerned". Commission Decision 2010/477/EU sets out the MSFD's criteria and methodological standards and under Descriptor 1 includes criteria "1.1.Species distribution" and indicators "Distributional range (1.1.1)", "Distributional pattern within the latter, where appropriate (1.1.2)", and "Area covered by the species (for sessile/benthic species) (1.1.3)". At a country scale, Greece, Italy, and Spain have selected targets for marine turtles; Cyprus and Slovenia mention marine turtles in their Initial assessment, but do not set targets (Milieu Ltd Consortium. 2014; UNEP/MAP 2016). Italy has an MSFD target of reducing fishing pressure by decreasing accidental mortalities by regulating fishing practices, along with by-catch reduction in areas where loggerhead sea turtles aggregate and delineating the spatial distribution of turtles in areas with highest use of pelagic long line (southern Tyrrhenian and southern Ionian sea) and trawling (northern Adriatic). One of the MSFD targets of Spain is to reduce the main causes of mortality and reduction of turtle populations, such as accidental capture, collisions with vessels, intaking of litter at sea, introduced terrestrial predators, pollution, habitat destruction, overfishing.

9.3. Results of the assessment

Loggerhead and green sea turtles

For this indicator, both species have been combined as the same gaps exist for both. Specific details for green turtles on Cyprus are provided by Broderick et al. (2002) and Stokes et al. (2014), with published data lacking for most other sites in the Mediterranean.

Population size and growth (breeding grounds)

See Indicator 2 for details on this topic.

Internesting intervals of adult females (breeding grounds)

It is essential to quantify the internesting interval within and across years because this influences clutch frequency and will influence estimates of population size (see Indicator 2). The nesting interval is regulated by sea temperature (Hays et al. 2002), being longer when the sea temperature is cooler. Ranges from 12 to over 20 days have been detected within and across nesting sites in the Mediterranean (see Demography Working Group 2015 and Casale & Margaritoulis 2010 for ranges across Mediterranean populations).

Remigration intervals of adult males and females (breeding grounds)

Knowledge on remigration rates (breeding periodicity) of known females and how this changes with time (i.e. maturation of younger nesters or aging of older nesters) is essential as this will affect our ability to predict the total adult sex ratio of populations. Knowledge on female remigration intervals is again limited to Greece, Turkey and Cyprus. Females in Greece and Cyprus tend to have remigration intervals of approximately 2 years (Demography Working Group 2015 and Casale & Margaritoulis 2010), but can be 1-3, or more years (Schofield et al. 2009). For males, remigration intervals have only been documented for males on Zakynthos, which are primarily 1 year, but with some individuals that forage near Tunisia/Libya and the western basin returning every 2 years (Hays et al. 2014; Casale et al. 2013). To determine the total number of adults in the population, clear knowledge about remigration frequency is required.

Clutch frequency (breeding grounds)

This parameter is difficult to quantify due to difficulty in detection rates. Clutch frequencies of 1.2-2.2 have been suggested for green and loggerhead turtles on Cyprus (Broderick et al. 2002). However, on Zakynthos, loggerhead turtles have mean clutch frequencies of 2-3 nests, with up to 5 occurring, based on satellite tracking studies (Zbinden et al. 2011; Schofield et al. 2013a). As this parameter is critical for inferring the numbers of females at breeding sites, as most estimates of females are estimated from nest counts divided by the assumed clutch frequency, it is essential to understand this parameter. Furthermore, clutch frequency will vary with internesting period; i.e. in warmer years, a female could lay more clutches due to shorter internesting periods and vice versa. Again, this information will influence population estimates.

Sex ratios of adult male and females (breeding grounds)

Once information on clutch frequency and remigration interval is robust, then estimates of the numbers of females can be obtained. However, to quantify adult sex ratios at the breeding grounds and overall for the adult component of sea turtle populations, counts of males in the marine environment during breeding must be made. Thus, at present, knowledge about the number of males that frequent breeding areas is non-existent. Therefore, we do not know how many males are currently breeding with females or what the sex ratios are for adults. Only on Zakynthos has a prediction been made of 1:3.3 males to females based on in-water photo-id surveys of a portion of the breeding population (Schofield et al. 2009). Thus, efforts are needed to quantify the number of males (See indicator 2 for more on this issue) in order to understand adult sex ratios and their potential implications on the conservation and persistence of the species.

Offspring sex ratios at breeding sites, including incubation (breeding grounds)

Estimated hatchling sex ratios exist for a number of nesting sites in Greece, Turkey and North Cyprus, as well as Tunisia (Hays et al. 2014) (Figure 1), with all being strongly female biased. For all the other nations there are no published accounts of estimated sex ratios (see Demography Working Group 2015). It is possible to infer offspring sex ratio from sand temperatures and incubation duration (e.g. Godley et al. 2001; Katselidis et al. 2012), which is relatively straight forward. Incubation duration has been recorded in most countries (see Demography Working Group 2015 and Casale & Margaritoulis 2010 for details).

Breeding success of adult males and females (breeding grounds)

Less is known regarding the breeding success of individual females and males. For females, breeding success should be measured generally and for individuals. General measures include the total number of female emergences versus successful nests. This information is generally collected by established beach-based monitoring programs in Greece, Turkey and North Cyprus. Furthermore, breeding success by females is reflected in fecundity (birth rates), i.e. the number of offspring an individual in a population produces. While information on emergence and hatching success is available for established beach-based monitoring programs in Greece, Turkey and North Cyprus, it is not linked to individual turtles in these programs. This is due to issues with tags falling off, knowledge about the successful production of offspring within and across years by individuals is not known, but could help towards indicating the fitness of individuals which could be used to infer the general health of the population.

With respect to males, just one study on multiple paternity has been conducted (Zbinden et al. 2007) on Zakynthos, showing higher than expected multiple paternity levels. Thus, some males might be more successful at mating with females than other males. Therefore, baseline data on the reproductive activity and success of individual males needs to be documented, again to ascertain their reproductive health and how this transforms to their contribution to the clutch (i.e. number of eggs represented by each male).

Hatchling success and emergence success (breeding grounds)

Hatchling success (i.e. number of eggs that hatch; 60-80%) and hatchling emergence success (the number of hatchlings that make it out of the nest; 60-70%) has been documented for the major nesting countries of Greece, Turkey and Cyprus, but more information is required from the other countries (for more details see, Demography Working Group 2015 and Casale & Margaritoulis 2010).

Recruitment, mortality, longevity of breeding (breeding grounds)

With the use of reliable tagging methods (i.e. use of 2 or more complementary techniques to ensure information on individuals is not lost; see Indicator 2), this information should be available for some nesting populations with long-term tagging programs (for example see, Dutton et al. 2005 and Stokes et al. 2014). At present recruitment is inferred by most tagging programs (i.e. in Greece, Turkey and Cyprus) from the absence of scars on flippers; however, this technique is not reliable. However, it is essential for existing and new programs to ensure continuous records of individual females, so that these key parameters can be assessed, which will help improve predictions of population recovery or decline.

Growth rates

A study of juvenile loggerheads sampled along the coast of Italy showed that growth rates differ between individuals of Atlantic and Mediterranean origin (Piovano et al. 2011). Casale et al. (2009, 2011) has assessed growth rates using skeletochronology and length-frequency analyses around Italian waters in the Adriatic. Studies of the growth rates of juveniles from different areas of the Mediterranean, however, are required, as these rates will vary depending on forage type. For instance, the size ranges of adult turtles tracked to the Adriatic, Ionian and Gulf of Gabes showed that those that migrated to the Adriatic were the largest, while those from the Ionian were intermediate in size and those from the Gulf of Gabes were the smallest (Schofield et al. 2013, supplementary literature); thus, the location of foraging sites likely influences the growth rates of juveniles. Because there is strong overlap in foraging site used by different populations, genetics analyses should be made in parallel to studies on growth rates. Genetic sampling is required to distinguish origin, with skeletochronology being the advised method to assess growth rates (Demography Working Group 2015); although, this can only be done on dead individuals at present. Studies of growth rate and age at first maturity of loggerhead sea turtles of Mediterranean origin are needed in the Adriatic Sea, the Aegean Sea, the Libyan Sea, the Levantine Sea, the Tyrrhenian Sea and the Balearic Sea (Demography Working Group 2015).

Sex ratios of juveniles and adults (developmental and foraging grounds)

Estimates of juvenile and adult sex ratios at foraging grounds have been completed by only a few studies in the Mediterranean using capture-recapture or bycatch. Different adult sex ratios might be associated with different neritic areas; thus estimates should be made at the level first, then at regional level. Generally balanced adult sex ratios have been documented for adults, ranging from 40-60% female bias, while 52-60% female bias has been documented for females (for overview see Casale et al. 2014). Studies on adults have been limited to the central Mediterranean, Italy, Greece (north-west section of Amvrakikos Gulf) and the southeast Tyrrhenian Sea to date (Casale et al. 2005, 2014; Rees et al. 2013). For juveniles, studies have been conducted at sites in the northwest Mediterranean, southwest Adriatic, north-east Adriatic and southeast Tyrrhenian (Casale et al. 1998, 2006; Maffucci et al. 2013). Of note, satellite tracking studies indicate that male loggerheads that breed on Zakynthos (Greece) forage along the entire Peloponnese mainland, whereas most females migrate at least 100 km away from the site (up to 1000 km) (Schofield et al. 2013b); thus, the Peloponnese might exhibit a strong male bias in terms of foraging habitat use. Furthermore, within the breeding area of Zakynthos, resident males occupied distinctly different foraging sites compared to breeding females (Schofield et al. 2013a), showing that sex specific differences might even occur on very small scales.

Therefore, existing values on sex ratios should be treated with caution. For instance, satellite tracking studies of turtles from Zakynthos (Greece) to Amvrakikos Gulf (Greece) (Zbinden et al. 2011; Schofield et al. 2013b) showed that males and females forage in all parts of the gulf, with females particularly using the southern and south-western areas. However, the study by Rees et al. (2013) was focused in a north-west section of the gulf, and so is not necessarily representative of the male:female ratios of this foraging ground. Thus, extensive surveys are required in most areas of the Mediterranean, with clarification on the area sampled related to the region and justification of its representativeness.

Physical parameters (breeding and foraging grounds)

The carapace dimensions (curved [(CCL)] and straight [(SCL)] length and width [(CCW and SCW)]) tend to be measured in all programs that tag females on nesting beaches, as well as capture-recapture and bycatch studies of juveniles and adults in the marine environment. This information has shown that female loggerheads nesting in the Mediterranean are the smallest in the world, with those nesting on Cyprus being the smallest (Broderick and Godley 1996; Margaritoulis et al. 2003). However, variation in body size within populations has also been documented, and might be associated to foraging site use (Zbinden et al. 2011; Schofield et al. 2013b; Patel et al. 2015). For morphometric measurements across the different breeding sites see Casale & Margaritoulis (2010). Furthermore, capture-recapture studies of juvenile and adult turtles have shown that turtles in the Mediterranean mature at >70 cm CCL, respectively (Casale et al. 2005, 2013, Rees et al. 2013), with visual differentiation at <75-80 cm CCL (for smaller turtles, other techniques must be used to distinguish between males and females). However, White et al. (2013) found that in the Drini Bay population (Albania), tail elongation began at 60cm CCL. In Amvrakikos Gulf, which hosts loggerheads of similar demographic groups that also originate in Greek rookeries, tail elongation was considered to begin at 64.6 to 69.8cm CCL (Rees et al. 2013), with nesting females of 70 cm CCL regularly nest on beaches in Greece and Cyprus (Margaritoulis et al. 2003).

However, measures of biomass are less common, but are of importance. Furthermore, documenting the frequency of carapace injury to known individuals could provide an important means of inferring their exposure to boats. Indices of body fat status are rare (Heithaus et al. 2007). Furthermore, blood and tissue samples are only collected under certain conditions; thus, information on the actual health of individuals remains sparse. This information could be used for genetic analysis to determine the source population of individuals and stable isotope analyses to indicate general foraging areas used by the individuals.

Genetic parameters (breeding and foraging grounds)

A large quantity of genetic information has been collected on sea turtles in the Mediterranean; however, information at specific foraging and breeding grounds is required. This information could be applied towards distinguishing the breeding site origin of mixed foraging and developmental stocks.

At present, genetic studies indicate the existence of six distinct loggerhead populations in the Mediterranean: Libya, Dalyan, Dalaman, Calabria, Western Greece and Crete and the Levant (central and eastern Turkey, Cyprus, Israel and Lebanon, and possibly Egypt) (Carreras et al. 2014; Saied et al. 2012; Yilmaz et al. 2012; Clusa et al. 2013; Demography Working Group 2015). In contrast, turtles nesting in Tunisia are not genetically distinct (Chaieb et al. 2010). No major genetic structuring has been detected for green turtles in the Mediterranean to date; however, as analyses evolve, updates may arise (Tikochinski et al. 2012).

Genetic analyses (e.g. mixed stock analysis and microsatellites) has shown the origin of turtles recorded at several Mediterranean foraging grounds (Maffucci et al. 2013; Giovannotti et al. 2010; Carreras et al. 2014; Yilmaz et al. 2012; Garofalo et al. 2013; Clusa et al. 2013). When combined with tracking datasets, these data reinforce the fact that turtles from different populations mix in the same foraging grounds (see Schofield et al. 2013b for overview; and details in Indicator 1).

However, at present it is difficult to assign individuals of unknown origin to distinct nesting populations using current genetic markers. Future studies need to build on this issue.

Furthermore, it is important to establish the genetic diversity within breeding populations, for both males and females, to evaluate health and potential changes in status. It is generally assumed that females and males return to breed at natal sites (Bowen et al. 2004). However, males have been shown to frequent multiple sites during the breeding period (Schofield et al. 2013; Casale et al. 2013). Moreover, genetic studies indicate high levels of multiple paternity on Zakynthos, which might be a mechanism to help enhance the genetic diversity of the population (Lee et al. in submission); although further examination of this phenomenon across different populations with different ratios of males and females and encounter rates (linked to how aggregated populations are) is needed.

Mortality including bycatch (breeding and foraging grounds)

Several countries in the Mediterranean have stranding networks and rescue centres (MEDASSET 2016). Gaps exist in the Middle East and North Africa. Within this framework, genetic, blood and tissue samples are collected, as well as information on animal morphometrics, including skeletochronology, and cause of trauma. However, strandings represent a minimum estimate of mortality because carcasses decompose rapidly while drifting in currents and eddies and eventually sink (Epperly et al., 1996; Hart et al. 2006); consequently, many dead turtles probably never reach shore. By-catch information from different regions of the Mediterranean has been assimilated (for details see Demography Working Group 2015). Casale (2011) suggesting more than 132,000 incidental captures per year in the Mediterranean, of which more than 44,000 are predicted to be fatal; however, current knowledge on post-release mortality is restricted and needs further quantification (Álvarez de Quevedo et al. 2013). Of note, at least, 50% of small scale fisheries fleets are concentrated in the Aegean Sea, Gulf of Gabès, Adriatic and Eastern Ionian Sea, which represent the four major foraging grounds for loggerhead and green turtles in the region (for details see Demography Working Group 2015).

9.4. Conclusions and identification of gaps

At present our knowledge on sea turtle demography is patchy at best for each component, with certain information being more widely available than other information. To understand the demography of loggerhead and green turtle populations in the Mediterranean, greater effort needs to be placed on filling existing gaps. Only then can we predict with any certainty the future viability of sea turtle populations in the Mediterranean.

Summary list of gaps

- Knowledge on the sex ratios within different components (breeding, foraging, wintering, developmental habitats), age classes and overall within and across populations.

- Knowledge about recruitment and mortality into different components of the population
- Knowledge about the physical and genetic health status of these groups.
- Vulnerability/resilience of these populations/sub-populations in relation to physical pressures;
- Analysis of pressure/impact relationships for populations/sub-populations and definition of qualitative GES;
- Identification of extent (area) baselines for each population/subpopulation and the habitats they encompass;
- Monitor and assess the impacts of climate change on offspring sex ratios.

10. Common Indicator 5: Population demographic characteristics (sea birds) (EO 1)

(To be determined)

11. Common Indicator 6: Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species (NIS) (EO 2)

11.1. Work undertaken to define indicators, key pressures and drivers

The February 2014 Integrated Correspondence Group on GES and Targets (Integrated CorGest) of the EcAp process of the Barcelona Convention selected the Common Indicator 6 “Trends in the abundance, temporal occurrence and spatial distribution of non-indigenous species, particularly invasive nonindigenous species, notably in risk areas in relation to the main vectors and pathways of spreading of such species” from the integrated list of indicators adopted in the 18th Conference of the Parties (COP 18), as a basis of a common monitoring program for the Mediterranean in relation to non-indigenous species. The Integrated Monitoring and Assessment Programme (IMAP), adopted at the 19th Conference of the Parties to the Barcelona Convention (COP 19) in Athens, included definitions of ecological objectives, operational objectives and related indicators for the implementation of the EcAp, as well as guidelines for monitoring to address Common Indicator 6. Four main pathways, i.e. the Suez Canal, shipping, aquaculture, and aquarium trade, were identified as the main drivers of species introduction in the Mediterranean.

11.2. Policy context and targets

The CBD’s Aichi Biodiversity Target 9 is that “by 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment”. This is also reflected in Target 5 of the EU Biodiversity Strategy (EU 2011). The new EU Regulation 1143/2014 on the management of invasive alien species seeks to address the problem of IAS in a comprehensive manner so as to protect native biodiversity and ecosystem services, as well as to minimize and mitigate the human health or economic impacts that these species can have. The Regulation foresees three types of interventions: prevention, early detection and rapid eradication, and management.

The Marine Strategy Framework Directive (MSFD) specifically recognizes the introduction of marine alien species as a major threat to European biodiversity and ecosystem health, requiring EU Member States to include alien species in the definition of GES and to set environmental targets to reach it. Hence, one of the 11 qualitative descriptors of GES defined in the MSFD is that “non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem” (Descriptor 2). Among the indicators adopted to assess this descriptor are “trends in abundance, temporal occurrence and spatial distribution in the wild of non-indigenous species, particularly invasive non-indigenous species, notably in risk areas, in relation to the main vectors and pathways of spreading of such species”. Ecological Objective 2 and the Common Indicator 6 are in agreement with the MSFD objectives and targets.

11.3. Results of the assessment

Two basin-wide inventories of the marine alien species of the Mediterranean have been published the last years, by Zenetos et al. (2010, 2012) and Galil (2012). Furthermore, many national lists of marine alien species have been published, most of them the last decade, including Croatia, Cyprus, Greece, Israel, Italy, Libya, Malta, Slovenia, and Turkey.

All known alien species introductions have been compiled in the Marine Mediterranean Invasive Alien Species online database (MAMIAS; www.mamias.org), developed by RAC/SPA in collaboration with the Hellenic Centre for Marine Research (HCMR). According to MAMIAS, 1057 non-indigenous species have been reported in the Mediterranean Sea (excluding vagrant species and species that have expanded their range without human assistance through the Straits of Gibraltar), of which 618 are considered as established. Of those established species, 106 have been flagged as invasive. Among the four Mediterranean sub-regions, the highest number of established alien species has been reported in the eastern Mediterranean, whereas the lowest number in the Adriatic Sea (Table 1).

In terms of alien species richness, the dominant group is Mollusca, followed by Crustacea, Polychaeta, Macrophyta, and Fish (Fig. 1). The taxonomic identity of alien species differs among the four sub-basins, with macrophytes being the dominant group in the western and central Mediterranean and in the Adriatic Sea (Table 1).

Alien species in the Mediterranean Sea are linked to four main pathways of introduction: the Suez Canal, shipping (ballast waters and hull fouling), aquaculture, and aquarium trade. Overall in the Mediterranean, the Suez Canal is the most important pathway, contrary to the situation in Europe, where shipping is the most important (Fig. 2). Nevertheless, the importance of pathways varies among the four Mediterranean sub-regions, with shipping being the most important pathway in the western and central Mediterranean and the Adriatic (Table 1). An assessment of the ‘gateways’ (i.e. countries of initial introduction) to alien invasions in the European Seas (Nunes et al. 2014) revealed marked geographic patterns depending on the pathway of introduction. The Suez Canal was the predominant pathway of first introductions in Egypt, Lebanon, Israel, Syria and the Palestine Authority (all in the eastern Mediterranean), representing more than 70% of each country’s first introduction events. For the other Mediterranean countries, shipping was the predominant pathway of initial introduction.

New introductions of alien species in the Mediterranean Sea have an increasing trend in the rate of new introductions by 30.7 species per decade, and the current (as of the 2000s) rate of new introductions exceeds 200 new species per decade (Fig. 3). However, this increasing trend in the rate of new introductions mainly reflects new introductions in the eastern Mediterranean, while in the other sub-regions the rate of new introductions is decreasing (Fig. 4).

The cumulative impact of alien species on the Mediterranean marine habitats was recently assessed and mapped, using the CIMPAL index, a conservative additive model, based on the distributions of alien species and habitats, as well as the reported magnitude of ecological impacts and the strength of such evidence (Katsanevakis et al. 2016). The CIMPAL index showed strong spatial heterogeneity, and impact was largely restricted to coastal areas (Fig. 5).

11.4. Conclusions and identification of gaps

Important progress has been made the last decade in creating inventories of non-indigenous species, and on assessing pathways of introduction and the impacts of invasive alien species on a regional scale. The development and regular updating of MAMIAS substantially contributes to address Common Indicator 6.

Nevertheless, research effort currently greatly varies among Mediterranean countries and thus on a regional basis current assessments and comparisons may be biased. Evidence for most of the reported impacts of alien species is weak, mostly based on expert judgement; a need for stronger inference is needed based on experiments or ecological modelling. The assessment of trends in abundance and spatial distribution is largely lacking. Regular dedicated monitoring and long time series will be needed so that estimation of such trends is possible in the future. NIS identification is of crucial importance, and the lack of taxonomical expertise has already resulted in several NIS having been overlooked for certain time periods. The use of molecular approaches including bar-coding are often needed to confirm traditional species identification.

12. Marine food webs (EO 4)

Food webs are defined as interconnected systems of consumer-resource relationships within biological communities, characterized by specific structure (taxonomic composition and diversity), functional organisation (trophic and other ecological interactions), and dynamics (patterns of change, resistance to change, ability to recover). Human activities produce major direct and indirect impacts on marine food webs at different spatial and temporal scales, with either *bottom-up* repercussions - from lower to higher trophic levels - or cascading, *top-down* consequences – from higher to basal trophic levels. Understanding of food webs features and properties is now recognized as indicative of ecosystem health, a key instrument on assessing potential environmental threats of human activities. The determination of Good Environmental Status in the European marine areas, as prescribed by the European Union's Marine Strategy Framework Directive (2008/56/EC) (MSFD), and its accompanying Commission Decision (2010/477/EU), must be based on 11 qualitative descriptors. Among these, Descriptor 4 addresses food webs: "*All elements of the marine food webs, to the extent that they are known, occur at normal abundance and diversity and levels capable of ensuring the long-term abundance of the species and the retention of their full reproductive capacity".*

In the Mediterranean, the pristine state of marine food webs has been at various level affected by a long history of exploitation and human-mediated disturbances such as overfishing, climate change. eutrophication, pollution, habitat fragmentation and destruction, and alien species introduction, often acting in a synergetic fashion.

Overfishing and climate change

The Western Mediterranean is one of the European areas with the highest diversity of fish species (Nieto et al. 2015). However, the overexploited or collapsed fish stocks were increasing at a rate of approximately 44, 33, and 38 stocks every 10 years for the western, central, and eastern Mediterranean, respectively, between 1970 and 2010. The Eastern Mediterranean subarea is at highest risk of overexploitation because of its higher cumulative percentage of overexploited and collapsed stocks and lower percentage of developing stocks (Tsikliras et al 2015a, Stergiou et al 2016). Overall, Mediterranean marine food webs have been simplified (i.e. degraded) by fisheries pressures: on average, 93% of assessed fish stock are severely overfished, ranging from 96% of demersal fish stocks to 71% or more for small pelagic fish stocks like sardine and anchovy. Overfishing has led to reduced abundance of large predator species and to an estimated reduction of one trophic level in the fisheries catches during the last half-century (UNEP/MAP 2012). Modelizations of Mediterranean food web structure also indicate a decreased connectance, lower omnivory, reduced robustness to species loss, and lower resilience to human pressures (Coll et al. 2008) Tzanatos et al. (2014) showed significant shifts in the fishery catches of the most important species/taxa paralleled an increasing temperature regime shift in the mid-late 1990s, with an average catch reduction of 44% for the majority of temperature-sensitive taxa (eg. Sardina pilchardus, Merluccius merluccius, Solea solea, Nephrops norvegicus). Increasing trends were found, mainly in the landings of species with short life spans and/or spring–summer spawning seasons (e.g. Engraulis encrasicolus).

Due to its semi-enclosed nature and geographic position, the sensitivity of the Mediterranean Sea to climate change is much higher than in other world ocean Large Marine Ecosystems (Belkin 2009). Over the last 30 years, the summer surface temperature increased 1,15 °C (Marbà et al. 2015) and climatic projections for the Mediterranean predict a much more frequent occurrence of extreme high temperatures and heat waves (Giorgi and Lionello, 2008). Such fast warming is expected to have major impacts on Mediterranean species' metabolic requirements for growth and reproduction (Ben Rais Lasram et al. 2010), and consequently, on food webs. Due to enhanced stratification and reduced input of nutrients into the euphotic zone, sea warming is known to cause reduction of primary production (Steinacher et al. 2010) and shifts in phytoplankton communities, with increase dominance of small-sized algal cells (picophytoplakton and nanoflagellates). Further, sea warming would increase phytoplankton sinking rate affecting its survival rate, with an overall impact on carbon cycling and global climate regulation (Milner et al 2016). As a corollary, the Mediterranean surface water communities will likely have reduced capacity to provide organic matter for higher trophic levels and the deep-sea ecosystems (The MerMex Group 2011). Information on potential changes on secondary production and their related impacts on Mediterranean food webs are still limited (Moullec et al. 2016). It has been suggested that failure in recruitment could be due to trophic mismatch between pre-recruits and their prey (Lejeusne et al. 2010). Sea warming as well as changes in river discharge and nutrients loads will likely have large consequences on recruitment success and production of various fish stocks and eventually on coastal food web integrity (Stergiou et al., 2016).

Besides changes in energy flows, modifications of food web structure (species composition) are expected to be a major effect of climate change. Jellyfish are among the fastest plankton components to respond to ongoing environmental changes in the Mediterranean Sea, and several carnivore species are characterized by extensive outbreak-forming potential. These may exhibit high consumption rates, rapid growth and high reproduction rates, and wide tolerance to ecosystem changes. Recent analyses of jellyfish population dynamics suggested increasing abundance and frequency of bloom formations in Mediterranean coastal zones in the last decades, with overfishing, sea warming, hydrographic changes, and coastal sprawl as multiple potential causative mechanisms (Molinero et al 2005, Licandro et al. 2010, Boero 2013; Canepa et al. 2014; Gueroun et al. 2015; Milisenda et al. 2016). High abundances of jellyfish are linked to drop in copepod abundances, with trophic shift from the crustacean-fish pathway towards a gelatinous one (Boero et al. 2008) and the replacement of high trophic level predators by jellyfish. The favorable time window for sexual reproduction of the Mediterranean dominant jellyfish, the mauve stinger Pelagia noctiluca, has extended throughout the year, leading to a potential continuous recruitment (Milisenda et al. 2016). As a result of sea warming and other human pressures, outbreaks of jellyfish are expected to become more frequent and prolonged in the Mediterranean basin.

Eutrophication, pollution, and marine litter

In the Mediterranean Sea, eutrophication remains a limited, although occasionally severe, phenomenon to specific coastal and adjacent areas. Rapid changes of abundances and distribution of lower trophic levels are determined by eutrophication and sea warming. Increase in SST and water column stability is promoting increased formation of mucilage aggregates in several sub-regions of the Mediterranean Sea (Moullec et al. 2016). Mucilages may regulate microbial diversity, facilitate the spread of specific pathogenic microorganisms, and cause hypoxia and anoxia events on benthic communities, determining mass mortalities of invertebrates with severe yet underestimated consequences on food webs (Danovaro et al. 2009).

Persistent pollutants may bioaccumulate in the food web affecting seafood, with its associated risk to human health, and conservation of intrinsically valued species (e.g. cetaceans). Chemical pollution by mercury and PAHs are of particular concern in the Mediterranean sea, because they are recognized as hazardous substances affecting marine ecosystem services, released by many land- and sea-based sources, and occurring at high levels in the marine environment. Mercury is never removed from the environment and eventually concentrates in sediments or in the biota. All monitored species of fish and mammals showed Hg concentrations above background natural levels, with several values above thresholds levels with respect to human health risk (Cinnirella et al 2013).

The Mediterranean Sea is among the most affected areas by plastic pollution and other forms (i.e. aluminium, glass) of marine litter (Eriksen et al., 2014; Galgani 2015, Suaria et al. 2016). As plastic breaks, microplastics (pieces of less than 5 mm in size) represent the most abundant form at sea. They can act both as source and vectors of chemical pollutants and microbes, accumulating in ocean gyres' neuston or at sea floor. The ingestion of plastics and other types of debris by marine suspension-feeders and deposit-feeders is well documented, and first evidences of trophic transfers are emerging. Understanding the risk of bioaccumulation and the potential path of microplastics through the marine food web trophic levels are of increasing urgency and importance to develop management measures, from prevention to recycling and disposal.

Non-indigenous species

On December 2015, the number of recorded multicellular non-indigenous species (NIS) in the Mediterranean were at 726, by far the highest compared with other European Seas (Galil et al. 2016). Out of them, 85% become established in the native communities, with a greater number in the East than in the West Mediterranean. The number of NIS in the Mediterranean more than doubled in the last 40 years. Sea warming and the most recent and major enlargement of the Suez Canal in 2015 are expected to maximize invasion success in the Mediterranean Sea of NIS with tropical and subtropical distributions and Indo-pacific origin, boosting their N-NW expansion rate and abundance (Tsikliras et al, 2015b), and potentially replacing native species with similar habitat requirements (e.g. Mullus spp replaced by Upeneus spp., Sarpa salpa by Siganus spp., E. encrasicolus by Etrumeus golanii, S.pilchardus and Sprattus sprattus by Sardinella aurita). Risk of species translocations by shipping, aquaculture, sea food trade in the Mediterranean are also still high, requiring reinforcement of surveillance and monitoring tools for prevention of new alien introductions.

Evaluations of NIS impacts on Mediterranean food webs are still scant. Single NIS species can potentially lead to substantial, highly detrimental modifications of the food web and ecosystem productivity, as determined by the impact of the non-indigenous ctenophore Mnemiopsis leidyi on the anchovy stocks in the Black sea (Shiganova 1998). In 2009, this voracious ctenophore was concurrently recorded across the Eastern and Western Mediterranean basin, and a new, diffuse outbreak of M. leidyi has occurred throughout spring-summer 2016 across the Adriatic Sea, Sicily Channel, and western Mediterranean; however, its impact on the Mediterranean pelagic food web is still to be clarified. Available information revealed resource partitioning and limited interspecific competition may support coexistence, rather than competitive exclusion, between indigenous and NIS species (Maric et al 2016). Nonetheless, more information is urgently needed on niche width and trophic plasticity of successful NIS to understand long-term effects of NIS and their potential threats on Mediterranean ecosystem functioning.

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Annexes

Annex 1: Common Indicator 3: Species distributional range (marine turtles) (EO1)

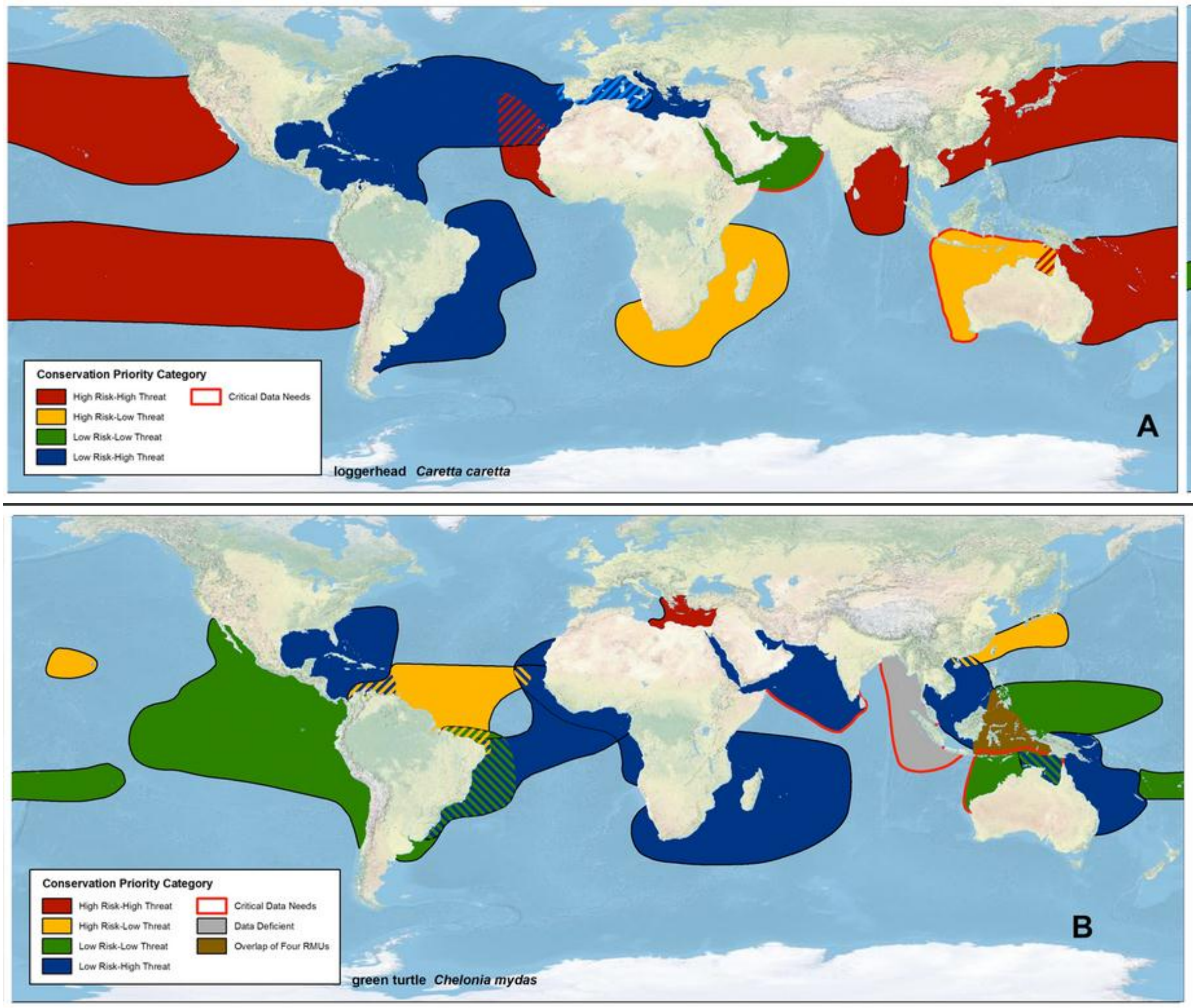


Figure 1Regional Management Units of sea turtle populations globally (extracted from Wallace et al. 2010, 2011). (A) Showing the 2 loggerhead RMUs in the Mediterranean and (B) showing the 1 green turtle RMU in the Mediterranean.

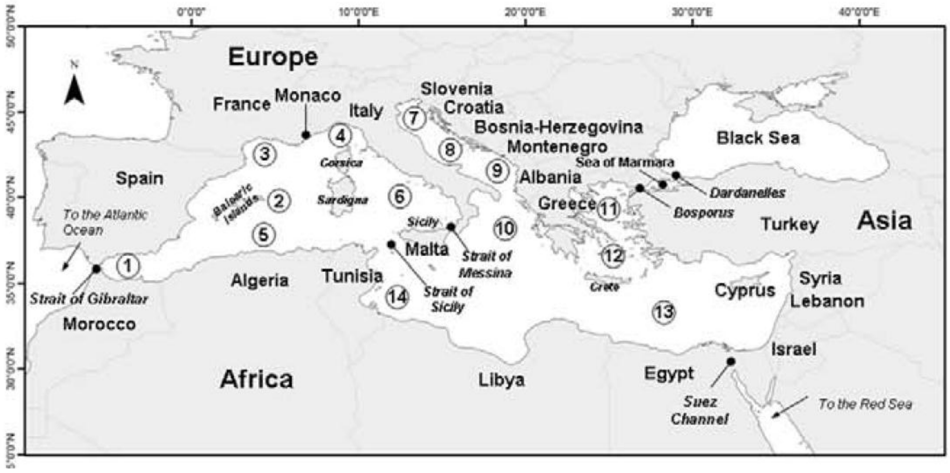


Figure 2.Main biogeographic regions of the Mediterranean Sea (extracted from Coll et al. 2011)

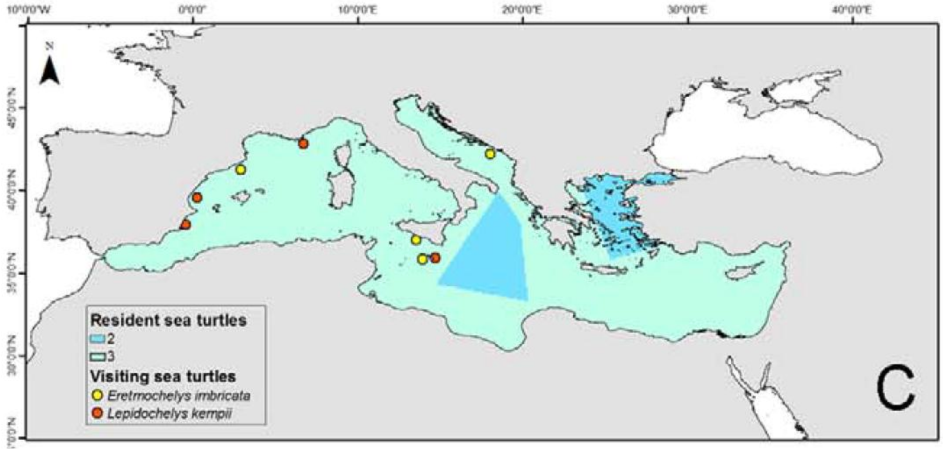


Figure 3. Modelled resident and sea turtle species richness (n = 3 species) in the Mediterranean (extracted from Coll et al. 2011)

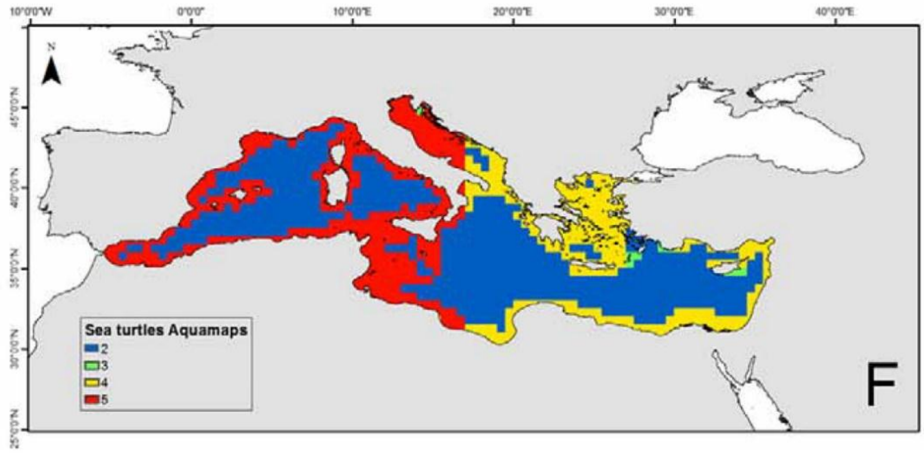


Figure 4. Aqua Map model of sea turtle distribution in the Mediterranean Sea (extracted from Coll et al. 2011). Note, this is primarily based on nesting beach data.

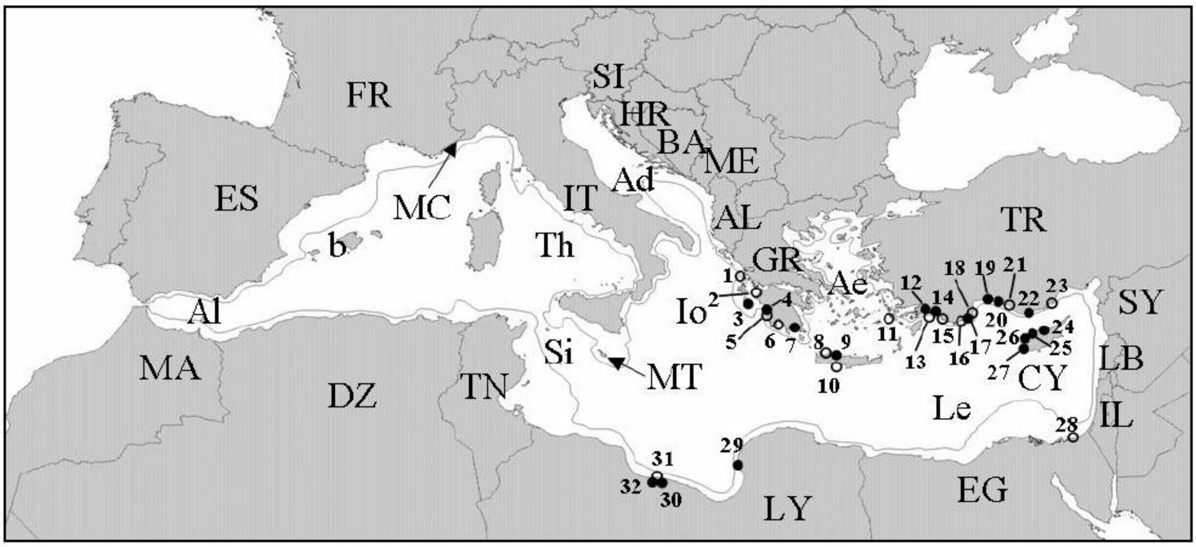


Figure 5. Map of the major loggerhead nesting sites in the Mediterranean (extracted from Casale & Margaritoulis)

Major nesting sites (>50 nests/year) of Loggerheads in the Mediterranean. 1 Lefkas; 2 Kotychi; 3 Zakynthos; 4 Kyparissia; 5 beaches adjacent to Kyparissia town; 6 Koroni; 7 Lakonikos Bay; 8 Bay of Chania; 9 Rethymno; 10 Bay of Messara; 11 Kos; 12 Dalyan; 13 Dalaman; 14 Fethiye; 15 Patara; 16 Kale; 17 Finike-Kumluca; 18 Cirali; 19 Belek; 20 Kizilot 21 Demirtas; 22 Anamur; 23 Gosku Delta; 24 Alagadi; 25 Morphou Bay; 26 Chrysochou; 27 Lara/Toxeftra; 28 Areash; 20 Al-Mteafla; 30 Al-Ghbeba; 31 Al-thalateen; 32 Al-Arbaeen. Closed circles >100 nests/year; open circles 50-100 nests/year. Country codes: AL Albania; DZ Algeria; BA Bosnia and Hersegovina; HR Croatia; CY Cyprus; EG Egypt; FR France; GR Greece; IL Israel; IT Italy; LB Lebanon; LY Libya; MT Malta; MC Monaco; ME Montenegro; MA Morocco; SI Slovenia; ES Spain; SY Syria; TN Tunisia; TR Turkey; Ad Adriatic; Ae Aegean; Al Alboran Sea; Io Ionian; Le Levantine basin; Si Sicily Strait; Th Thyrrenian; b Balearic

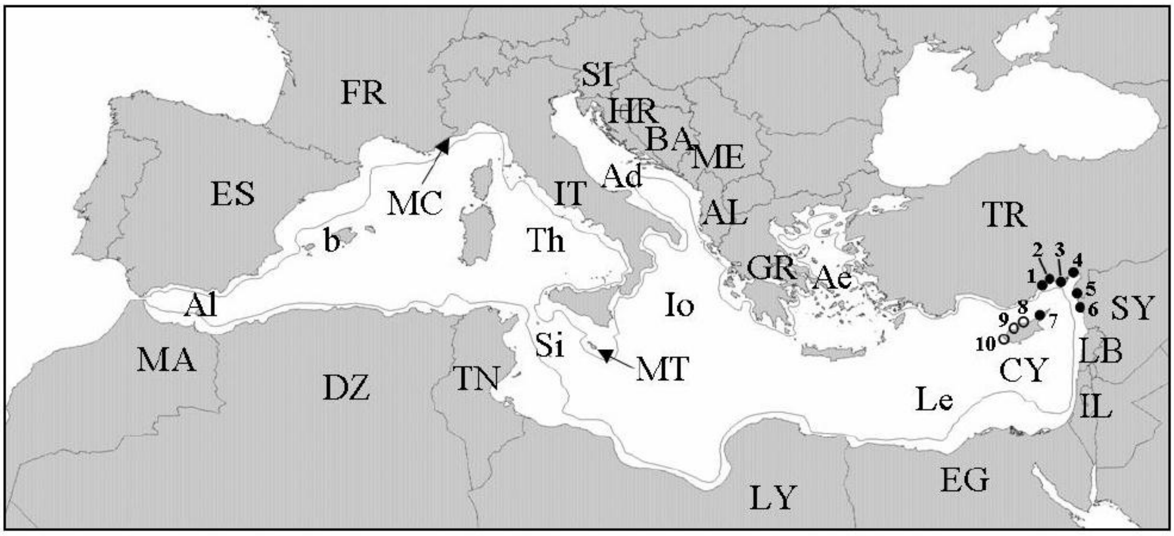


Figure 6. Map of the major green turtle nesting sites in the Mediterranean (extracted from Casale & Margaritoulis)

Major nesting sites (>40 nests/year) of green turtles in the Mediterranean. 1 Alata; 2 Kazanli; 3 Akyatan; 4 Sugozu; 5 Samandag; 6 Latakia; 7 North Karpaz; 8 Alagadi; 9 Morphou Bay; 10 Lara/Toxeftra. Closed circles >100 nests/year; open circles 40-100 nests/year. Country symbols, see previous map.

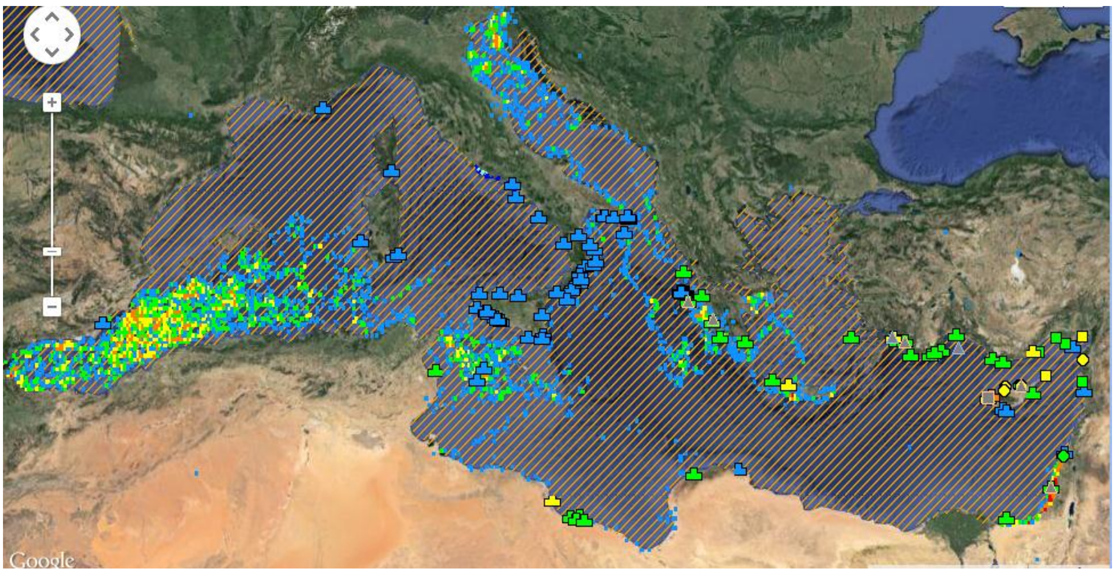


Figure 7. Image from OBIS-SEAMAP: State of the World's Sea Turtle (SWOT). The image presents an example for sea turtles, showing satellite tracking data (dots), nesting sites and genetic

sampling sites (shapes) that have been voluntarily submitted to the platform by data holders. Many datasets are missing, including several known nesting sites and a considerable amount of satellite tracking from the eastern, central and western Mediterranean (over 195 routes have been published, and many remain unpublished; Luschi & Casale 2014, Italian Journal of Zoology 81(4): 478-495). The distribution range (lines) of the three sea turtles species present in the Mediterranean encompasses the entire basin. Big gaps exist; yet, this is the only information currently available in the form of an online database and mapping application.

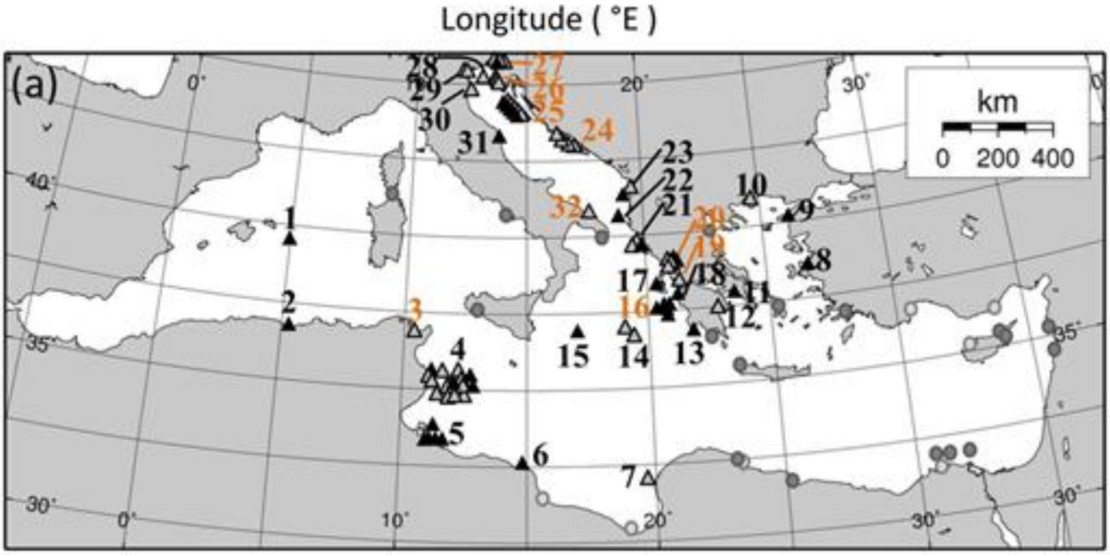


Figure 8. Foraging sites identified across the Mediterranean based on published papers (extracted from Schofield et al. 2013)

Discrete foraging sites frequented by male (black triangles) and female (grey triangles) loggerheads from Zakynthos (with some turtles frequenting more than one site). The foraging sites are indicated and numbered by open circles; orange circles = foraging sites overlapping or in close proximity to existing marine protected areas and/or national parks. Discrete foraging sites are arbitrary, and defined as a single site or group of overlapping sites that are separated from adjacent sites by a minimum distance of 36 km, which reflects the mean migration speed of loggerhead turtles (1.5 km h^{-1}; Schofield *et al.,* 2010) over a 24 h period. In addition, other known loggerhead (filled dark grey circles) and green turtle (filled light grey circles) foraging sites based on published datasets (Bentivegna, 2002; Margaritoulis *et al.,* 2003; Broderick *et al.,* 2007; Hochscheid *et al.,* 2007; Casale *et al.,* 2008). Note: solely juvenile foraging sites of the West Mediterranean have not been included here. The table below lists the different foraging sites, including the species, size class and genetic populations detected at these sites in various papers.

Table 1 (extracted from Schofield et al. 2013a).
Published literature used to identify overlap in foraging sites (A) based on tracking datasets and (B) based on genetic data. Foraging category, NO = neritic open sea; NC = neritic coastal. Thermal state, Avail = availability; Use = recorded use; Y-R = year round; S (Wi) = Seasonal (Winter); S (Su) = Seasonal (Summer); Unconf. = unconfirmed. Species, Log = loggerhead; Gre = Green; Gender/Ageclass, M = adult male; F = adult female; Juv = juveniles, with gender not differentiated. Breeding populations, ? = unconfirmed; Zak = Zakynthos, Greece; Kyp = Kyparissia, Greece; Cyp = Cyprus; Syr = Syria; T = Turkey; Lib = Libya; Tunis = Tunisia; Mess = Messina; Cal = Calabria; Is = Israel; It = Italy. Sources: 1 = current study; 2 = Casale *et al.*, (2007, 2010); 3 = Zbinden *et al.*, (2008, 2011); 4 = Margaritoulis *et al.*, (2003); 5 = Bentivegna (2002); 6 = Broderick *et al.*, (2007); 7 = Hochscheid *et al.*, (2007); 8 = Echwikhi *et al.*, (2010); 9 = Chaeib *et al.*, (in press); 10 = Houghton *et al.*, (2000); 11 = Rees *et al.* (2008), Rees & Margaritoulis (2008); 12 = Lazar *et al.*, (2004a,b); 13 = Vallini *et al.*, (2006); 14 = Carreras *et al.*, (2006); 15 = Casale *et al.*, (in press); 16 = Casale *et al.*, 2012 ; 17 = Saied *et al.*, 2012.

Foraging class site	**Basin Breeding (Log only)**	**Sea/ gulf**	**Country Sources**	**Foraging category**	**Avail.**	**Thermal available**	**Protection**	**Loggerhead**	**Green**	**Species No.**	**Populations**	**Gender /Age**
1	West	Balearic	Majorca	O	S (Su)	No	Log	M / Juv		1	Zak	1,2
2	West	Algerian coast	Algeria	NC	Y-R	No	Log	M		1	Zak	1
3	West	Gulf of Tunis	Tunisia	NC	Y-R	**Yes**	Log	F		1	Zak	1,3
4	Central	Gulf of Gabes	Tunisia	NC/NO	Y-R	No	Log	M /F / Juv		~10	Zak; Kyp; Cyp; Turk, Mess Tunis; Lib; ?Cal; ?Is; ?It	1,2,3,4,5,6 7,8,9,15,16
5	Central	Gulf of Gabes	Tunisia	NC/NO	Y-R	No	Log	M /F / Juv		~6	Zak; Kyp; Cyp; Turk;Tunis Tunis; Lib	1,2,3,5,6 7,8,17
6	Central	Gulf of Sindra	Libya	NC	Y-R	No	Log	F		2	Zak; Cyp	1,4,6
7	Central	Gulf of Sindra	Libya	NC	Y-R	No	Log	M /F		1	Zak	
8	East	Gulf of Izmir	Turkey	NC	S (Su)	**Yes**	Log	M		2	Zak; ?Kyp	1,4
9	East	Straits of Dardanelles		Turkey	NC	S (Su)	No Log		M	1		Zak
10	East	Aegean	Greece	NC	S (Su)	No	Log	F		2	Zak; ?Kyp	1,4
11	East	Aegean	Greece	NC	Y-R	No	Log	M		1	Zak	
12	East	Aegean	Greece	NC	Y-R	No	Log	F		2	Zak; ?Kyp	1,4
13	Central	Ionian	Greece	NC	Y-R	No	Log	M		1	Zak	
14	Central	Ionian	Greece	NC	Y-R	No	Log	F		1	Zak	1,3
15	Central	Ionian	Greece	O	Y-R	No	Log	M		1	Zak	
16	Central	Ionian	Greece	O	Y-R	**Yes**	Log	M		1	Zak	
17	Central	Ionian	Greece	NC	Y-R	No	Log	M		~3	Zak; Kef; Unkown	1,5,10
18	Central	Ionian	Greece	NC	Y-R	No	Log	M / F		2	Zak; ?Kyp	1, 4
19	Central	Ionian	Greece	NC	Y-R	**Yes**	Log	F		1	Zak	
20	Central	Amvrakikos	Greece	NC	Y-R	**Yes**	Log / Gre	M /F /Juv	Juv	~3	Zak; ?Kyp; Syr; Unknown	1,3,4,5,11

21	Central Adriatic	Greece	NC	Y-R	No	Log	M / F /Juv		1	Zak	1,2
22	Central Adriatic	Albania	O	Y-R	No	Log	M / Juv		1	Zak	1,2
23	Central Adriatic	Albania	NC	Y-R	No	Log	M / F / Juv		~2	Zak; Unknown	1,2,7
24	Central Adriatic	Croatia	NC/NO	Y-R	**Yes**	Log / ?Gre	F / Juv	Juv	2	Zak; Kyp	1,2,3,4,12
25	Central Adriatic	Croatia	NO	S (Su)	**Yes**	Log	M / F / Juv		2	Zak; Kyp	1,2,3,4,14
26	Central Adriatic	Croatia	NC	S (Su)	**Yes**	Log	F / Juv		3	Zak; Kyp; Lak, Cyp; Turk	1,2,3,4,12,14
27	Central Adriatic	Slovenia	NO	S (Su)	**Yes**	Log	M / F / Juv		1	Zak	1,2,3,14
28	Central Adriatic	Italy	NO	S (Su)	No	Log	F / Juv		1	Zak	1,2,3,4
29	Central Adriatic	Italy	NC	S (Su)	No	Log / ?Gre	F / Juv	Juv	1	Zak	1,2,3,12,13
30	Central Adriatic	Italy	NC	S (Su)	No	Log / ?Gre	F / Juv	Juv	1	Zak	1,2,3,12
31	Central Adriatic	Italy	NC	S (Su)	No	Log / ?Gre	F / Juv	Juv	1	Zak	1,2,12
32	Central Adriatic	Italy	NC	Y-R	**Yes**	Log / ?Gre	F / Juv	Juv	1	Zak	1,2,3,12

Annex 2: Figures related to Common Indicator 4: Species population abundance (marine turtles) (EO1)

Figure 1. Map of the major loggerhead nesting sites in the Mediterranean (extracted from Casale & Margaritoulis)

Major nesting sites (>50 nests/year) of Loggerheads in the Mediterranean. 1 Lefkas; 2 Kotychi; 3 Zakynthos; 4 Kyparissia; 5 beaches adjacent to Kyparissia town; 6 Koroni; 7 Lakonikos Bay; 8 Bay of Chania; 9 Rethymno; 10 Bay of Messara; 11 Kos; 12 Dalyan; 13 Dalaman; 14 Fethiye; 15 Patara; 16 Kale; 17 Finike-Kumluca; 18 Cirali; 19 Belek; 20 Kizilot 21 Demirtas; 22 Anamur; 23 Gosku Delta; 24 Alagadi; 25 Morphou Bay; 26 Chrysochou; 27 Lara/Toxeftra; 28 Areash; 20 Al-Mteafla; 30 Al-Ghbeba; 31 Al-thalateen; 32 Al-Arbaeen. Closed circles >100 nests/year; open circles 50-100 nests/year. Country codes: AL Albania; DZ Algeria; BA Bosnia and Hersegovina; HR Croatia; CY Cyprus; EG Egypt; FR France; GR Greece; IL Israel; IT Italy; LB Lebanon; LY Libya; MT Malta; MC Monaco; ME Montenegro; MA Morocco; SI Slovenia; ES Spain; SY Syria; TN Tunisia; TR Turkey; Ad Adriatic; Ae Aegean; Al Alboran Sea; Io Ionian; Le Levantine basin; Si Sicily Strait; Th Thyrrenian; b Balearic

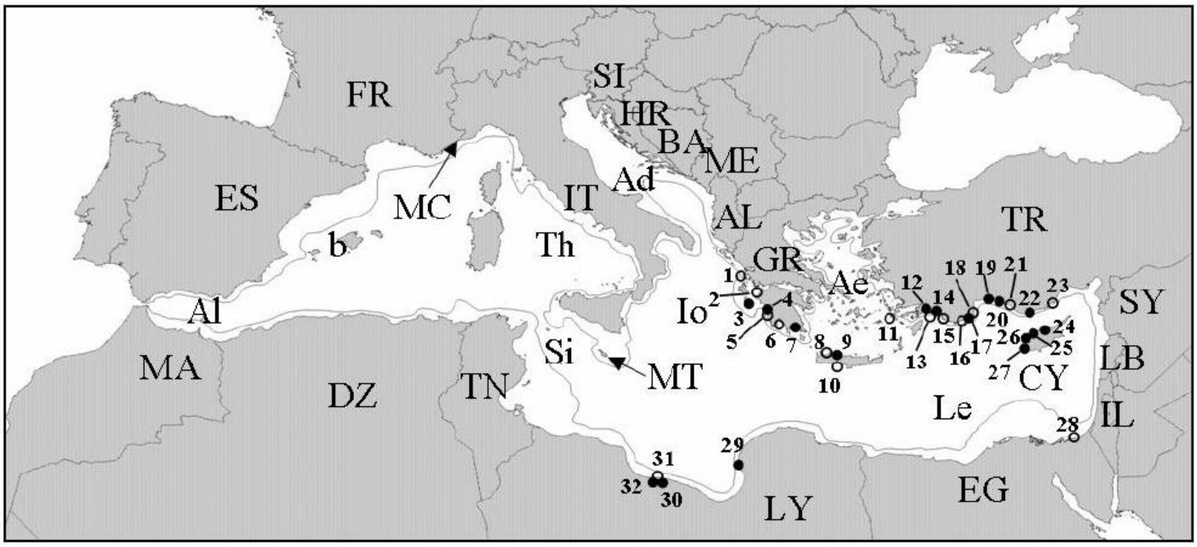
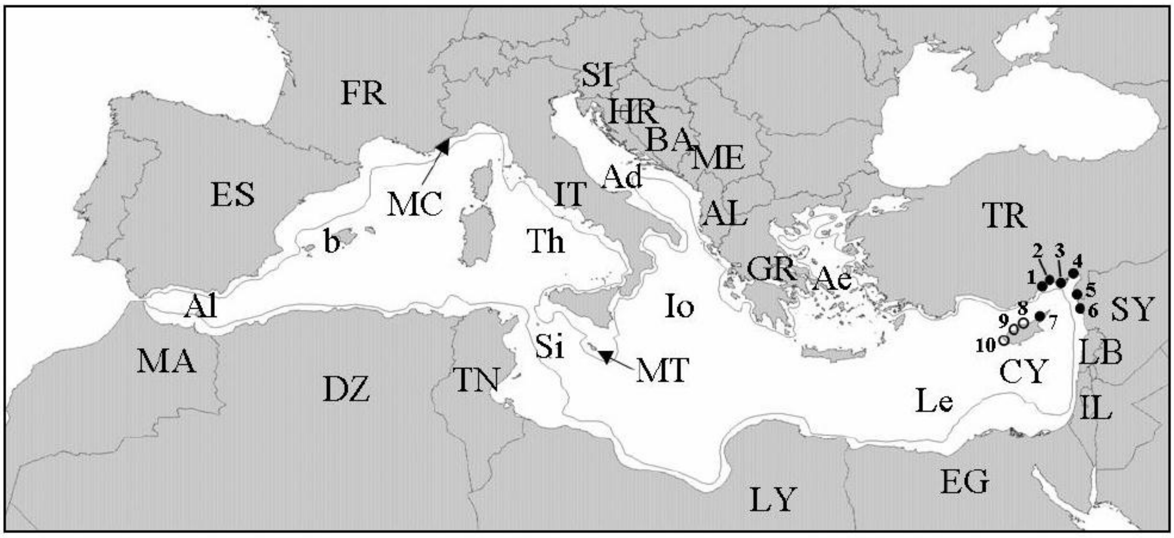


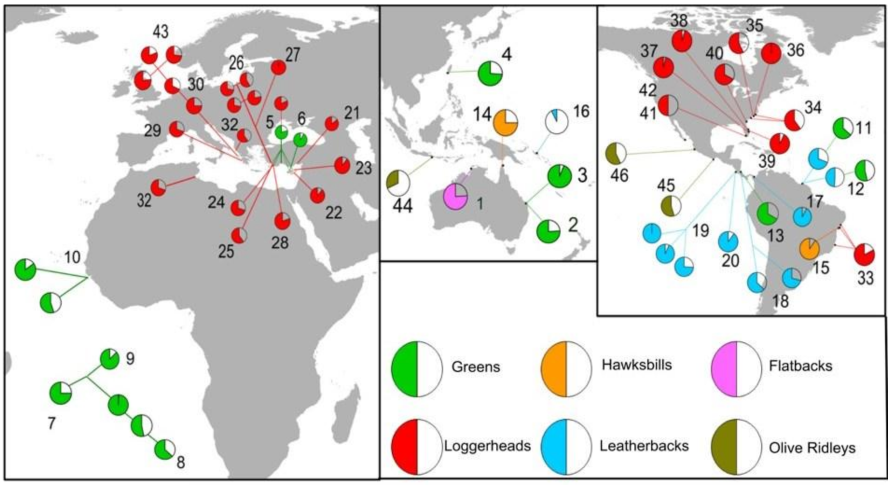
Figure 2. Map of the major green turtle nesting sites in the Mediterranean (extracted from Casale & Margaritoulis)

Major nesting sites (>40 nests/year) of green turtles in the Mediterranean. 1 Alata; 2 Kazanli; 3 Akyatan; 4 Sugozu; 5 Samandag; 6 Latakia; 7 North Karpaz; 8 Alagadi; 9 Morphou Bay; 10 Lara/Toxeftra. Closed circles >100 nests/year; open circles 40-100 nests/year. Country symbols, see previous map.



Annex 3: Figures related to Common Indicator 5: Population demographic characteristics (marine turtles) (EO1)

Figure 1 Offspring sex ratios globally, including the Mediterranean (extracted from Hays et al. 2014)



Annex 4: List of table and figures related to Common Indicator 6: Trends in abundance, temporal occurrence, and spatial distribution of non-indigenous species (NIS) (EO 2)

Table 1: Summarized information for each Mediterranean sub-region about the status of alien invasions. Sources: MAMIAS, Zenetos et al. (2012)

	eastern Mediterranean	**central Mediterranean**	**Adriatic**	**western Mediterranean**
number of established alien species	468	183	135	215
most important pathway of introduction	Suez Canal	shipping	shipping	shipping
2nd most important pathway	shipping	Suez Canal	aquaculture	aquaculture
richest taxons in alien biota	Mollusca, Crustacea	Macrophyta, Polychaeta	Macrophyta, Mollusca	Macrophyta, Crustacea
trend in the rate of new introductions (based on the last 3 decades)	increasing	decreasing	decreasing	decreasing

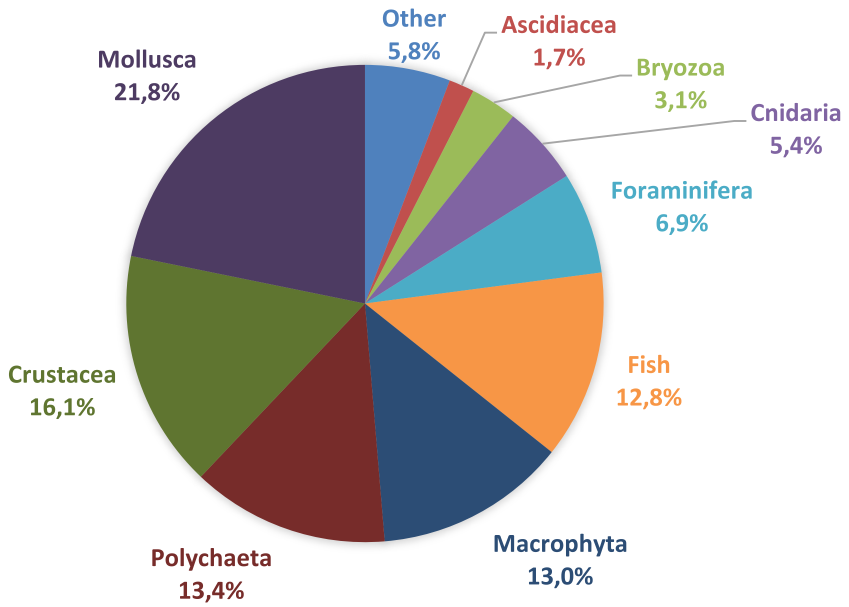


Figure 1: Contribution of the major taxa in the alien marine biota of the Mediterranean Sea. Modified from Zenetos et al. (2012).

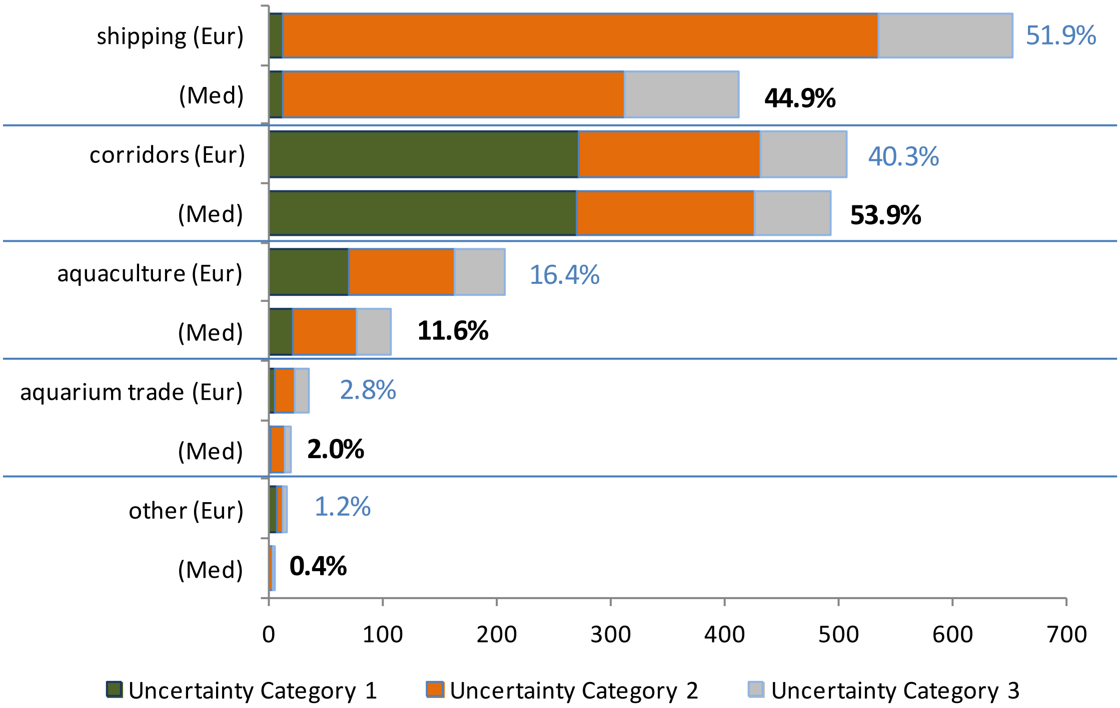


Figure 2: Number of marine alien species known or likely to have been introduced by each of the main pathways, in Europe (Eur) and the Mediterranean (Med). Percentages add to more than 100% as some species are linked to more than one pathway (blue percentages refer to the European total, while black percentages to the Mediterranean total). Uncertainty categories: (1) there is direct evidence of a pathway/vector; (2) a most likely pathway/vector can be inferred; (3) one or more possible pathways/vectors can be inferred; (4) unknown (not shown in the graph). Modified from Katsanevakis et al. (2013), Zenetos et al. (2012).

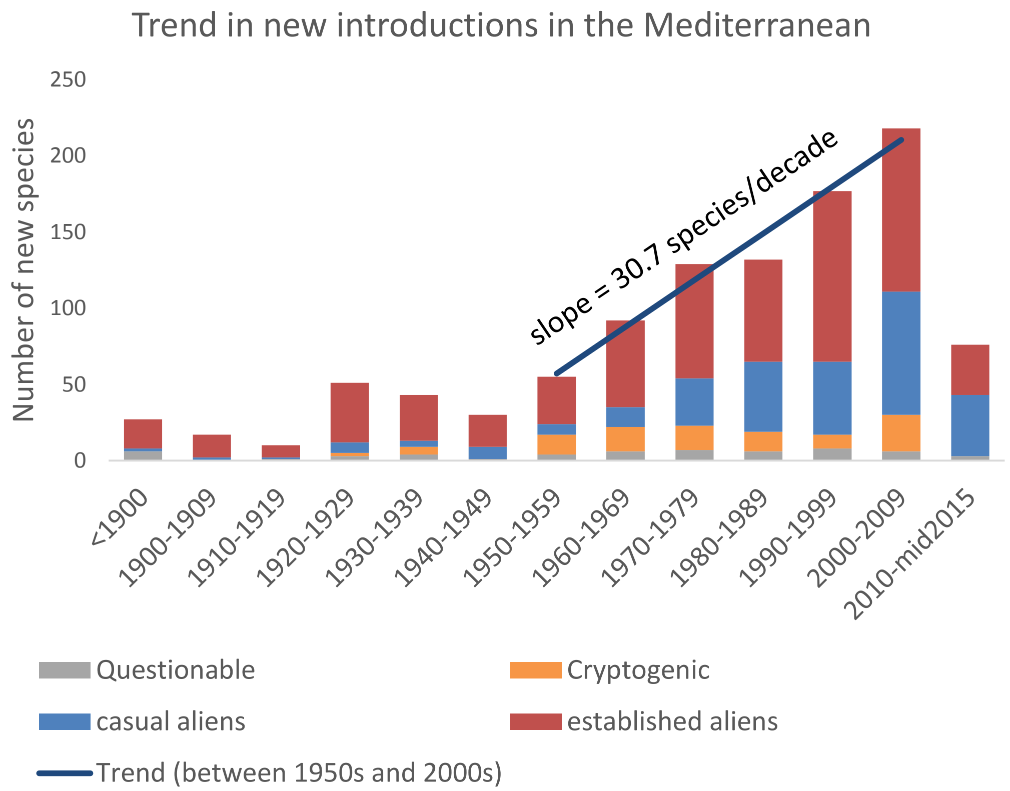


Figure 3: Trend in new introductions of alien marine species per decade in the Mediterranean Sea. Source: MAMIAS

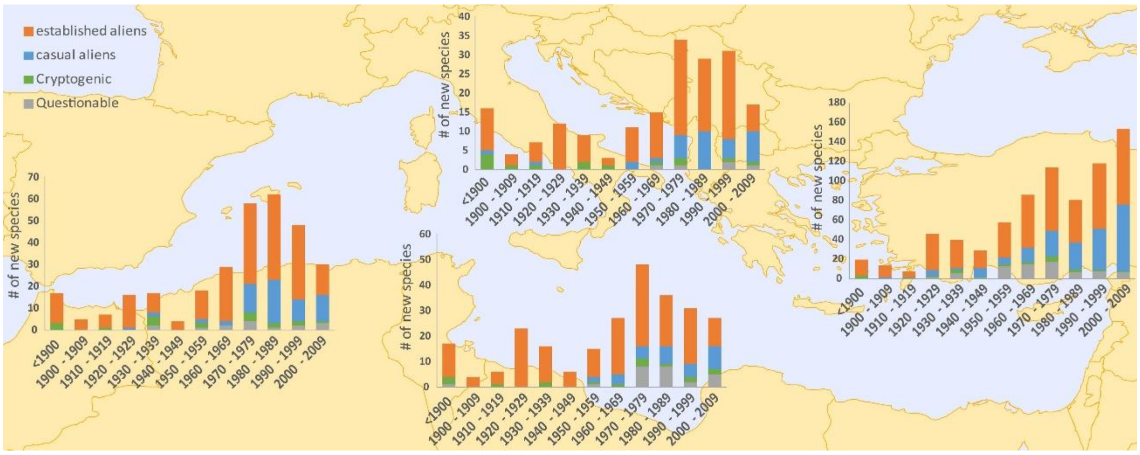


Figure 4: Trend in new introductions of alien marine species per decade in the Mediterranean sub-regions (eastern, central, western Mediterranean, and Adriatic Sea). Source: MAMIAS

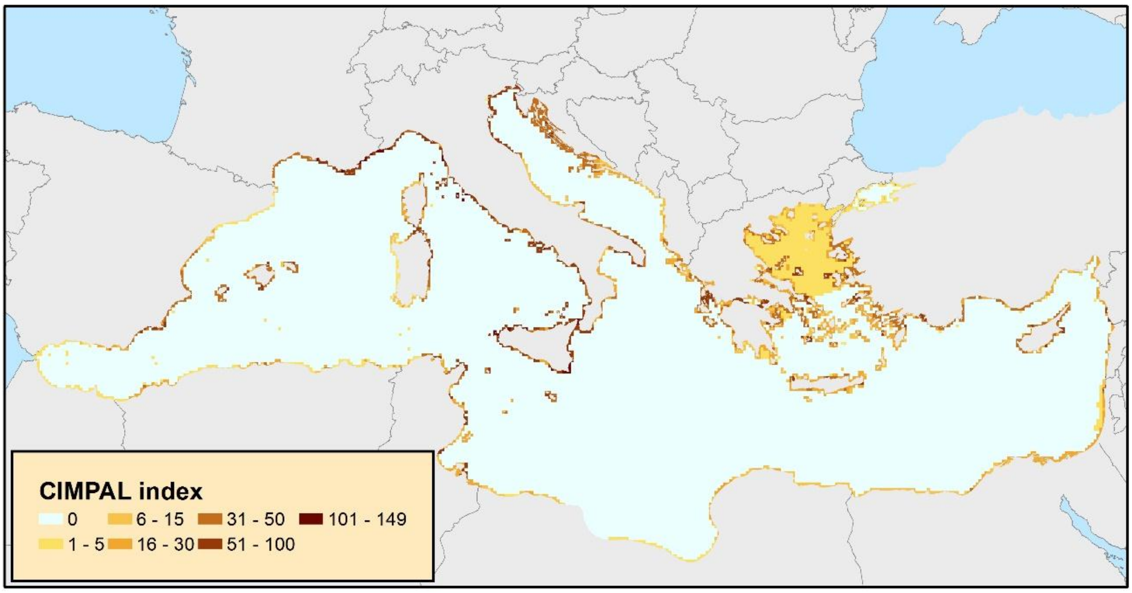


Figure 5: Map of the cumulative impact score (CIMPAL) of invasive alien species to marine habitats. Modified from Katsanevakis et al (2016).