

# BIODIVERSITY OF THE MEDITERRANEAN SEA: ESTIMATES, PATTERNS & THREATS

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## Abstract

**We reviewed available estimates of marine diversity in the Mediterranean Sea, we depicted main spatial and temporal patterns and we summarized main drivers of change and threats**

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**Introduction** The aims of our study were (i) to review available estimates of Mediterranean marine biodiversity, and update previous checklists, (ii) to depict the main spatial and temporal patterns of biodiversity, including innovative ways of describing marine diversity, and (iii) to summarize the main drivers of change and threats to marine biodiversity.

**Material and Methods** We used an extensive bibliographic search combined with the participation of several experts on Mediterranean biota to update publicly available estimates of major taxa, from microscopic organisms to vertebrates. This effort included new estimates of less conspicuous organisms. The new estimate was then compared with previous efforts within the region (1-4), and with online databases, and the state of knowledge by groups was assessed.

We used information available by region or sub-regions and by taxonomic group to depict spatial patterns of marine biodiversity. Patterns of primary producers and most invertebrate species could only be explored at the scale of large regions or basins. Detailed spatial patterns of vertebrate diversity (fish, marine mammals, marine turtles, and seabirds) were analyzed using Geographical Information System software (ArcView by ESRI) covering the Mediterranean basin after available data were digitized (e.g. 5). For each 0.1 degree grid cell, species richness was estimated as the sum of the species co-occurring. We also used the global species distribution model Aquamaps (www.aquamaps.org) to generate standardized range maps of occurrence for marine species. We then compared results with local distribution maps.

To describe temporal changes of diversity over time, we summarized information from several studies (e.g. 6-7) that dealt with the challenge of analysing and integrating diverse data. For the North Adriatic Sea, we included

results from Lotze et al. (6) who used a multi-disciplinary approach to assess the ecological changes and overall shift in diversity over historical time scales. We finally identified main current threats to diversity by large taxonomic groups, while special attention was given to climate change scenarios.

**Results and Discussion** Our analysis identified >17,000 species occurring in the Mediterranean Sea and updated previous estimates that were in the order of 8,000-12,000 species. However, our estimate is still incomplete as more species are likely to be described, especially of smaller and less conspicuous biota. Deep sea areas and portions of the southern region are also still poorly known for several taxonomic groups. In addition, the invasion of new species, especially through the Suez Canal, is a crucial factor that will continue to condition several aspects of Mediterranean marine biodiversity.

Spatial patterns confirmed a general decreasing trend in biodiversity from west to east and north to south, with exceptions. Biodiversity is higher in coastal areas and continental shelves, and decreases with depth. We provide a comprehensive set of species richness maps that represent a baseline for future analysis of biodiversity changes and trends, an important task within the context of global change and associated species' range shifts. The first attempt to depict hotspot areas for vertebrate species in the Mediterranean Sea may be useful for conservation planning (8).

Temporal trends indicate that exploitation and habitat loss where the main drivers of historical changes in biodiversity. More recently, habitat loss and degradation, pollution, climate change, over-exploitation and invasions are the most conspicuous threats that also impact the greatest number of taxa.

An important remaining task is the free distribution of publicly available data from national and regional research initiatives to facilitate updates and enable scientific discussion. We envision the need to continue the collaborative research effort that this work illustrates to further update marine biodiversity registries and narrow down the unknowns.

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