# Assessing the effectiveness of Protected Areas across the Mediterranean Island Hotspot

Brasini Giacomo, Testolin Riccardo, Gambetti Alberto, Santi Francesco, Chiarucci Alessandro

BIOME Lab, Department of Biological, Geological and Environmental sciences,
University of Bologna, via Irnerio 42, 40126 Bologna, Italy; giacomo.brasini5@unibo.it, riccardo.testolin@unibo.it, alberto.gambetti@studio.unibo.it, francesco.santi12@unibo.it, alessandro.chiarucci@unibo.it

## Introduction

The ongoing loss of biodiversity represents one of the most pressing environmental challenges of our time. The decline of species and ecosystems continues at unprecedented rates, threatening the resilience of natural systems and the essential services they provide to society. Islands with their high levels of enedemism and uniquess biotass are crucial for conservation, yet also highly vulnerable to habitat loss, biological invasions, and climate change[1]. Protecting island ecosystems is fundamental to conserving species that are not found elsewhere.

In this study, we focused on the Mediterranean Basin, one of the world's biodiversity hotspots, characterized by more than 11,000 islands and islets[2]. By integrating spatial data from the World Database on Protected Areas (WDPA) and the MEDIS[3] dataset, we quantified the extent and distribution of terrestrial protection across all Mediterranean islands.

This analysis contributes to assessing progress toward the Kunming–Montreal Global Biodiversity Framework for 2030, which calls for at least 30% of terrestrial and marine areas to be effectively conserved, including 10% under strict protection, by the year 2030.

## Methods

Data of Mediterranean islands were retrieved from the MEDIS database. The Protected Areas (PAs) boundaries were obtained from World Database on Protected Area (WDPA), using the `wdpar` R package. For each country, PA polygons were cleaned, validated and and intersected after reprojecting to the ETRS89–LAEA (EPSG:3035). For each island, total and class-specific protected surfaces (IUCN Ia–VI) and their relative percentages were calculated. Islands were grouped by size class and country to assess spatial protection patterns. A beta regression model tested the effect of island–mainland distance on protection extent. Finally, islands with surface ≥90% under strictly protected (IUCN Ia, Ib and II) were identified, summarized by country, and mapped across the Mediterranean basin.

## Results

Protection patterns vary with island size class and IUCN category (Fig. 1).

Large islands (> 1,000 km²) contribute most to the total protected surface, whereas small islands (1km² –10 km²) show the highest relative protection (more than 60%).

Strictly protected categories (Ia, Ib and II) dominate in small islands, while management types like IV and V prevail on the largest ones.

The beta regression model (Fig. 2) showed a significant positive relationship between island–mainland distance and the proportion of protected area, indicating that more remote islands are generally better protected. However, this trend varies across countries, reflecting national differences in conservation policies.

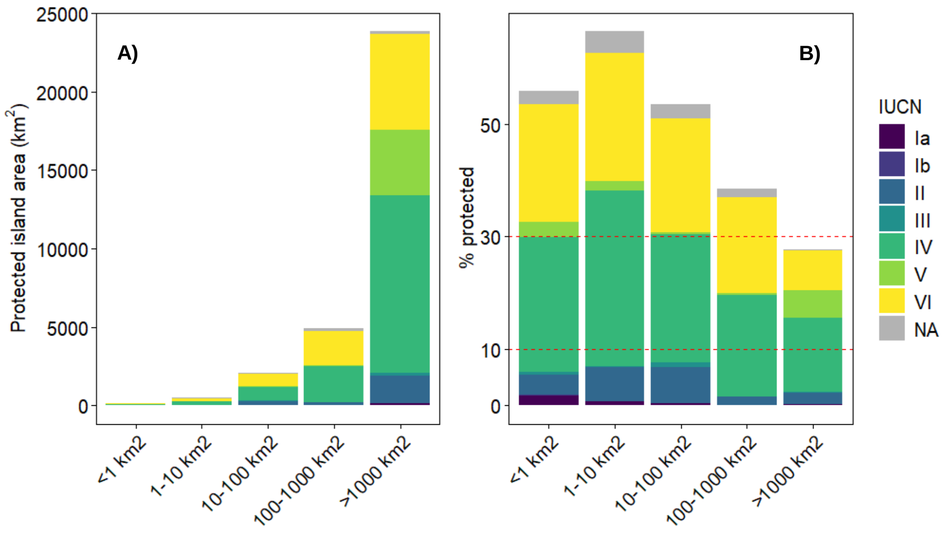


Fig. 1: A) Protected area by island size category, disaggregated by IUCN category. B) percentage of each island size class under protection, by IUCN category.

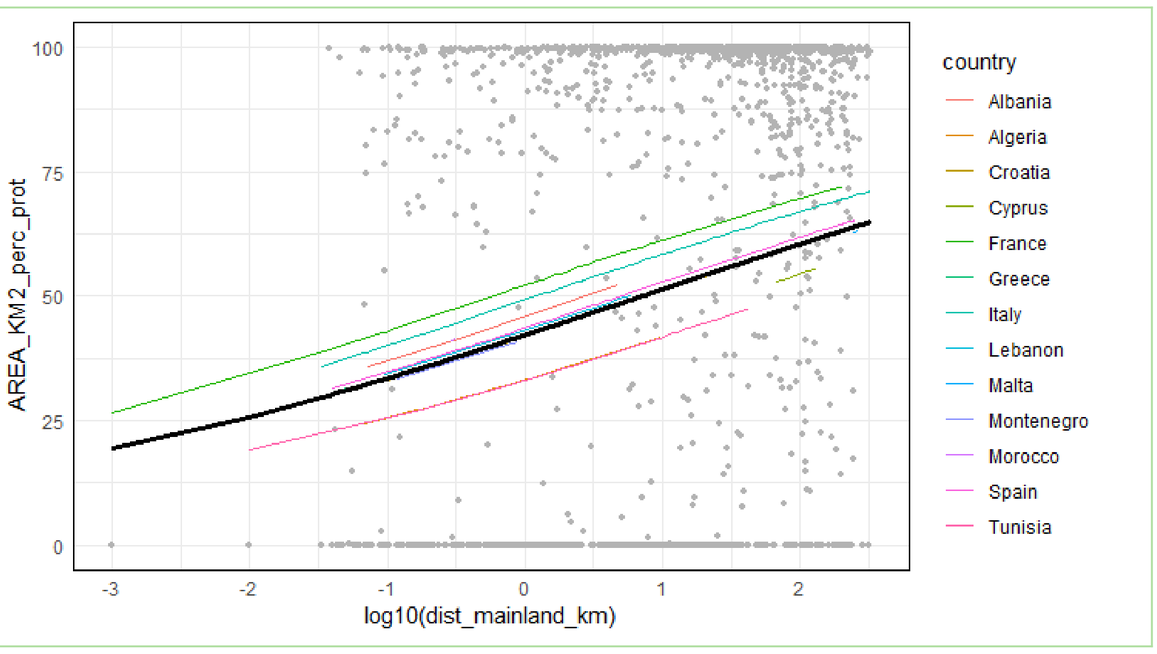


Fig. 2: Beta regression showing the relationship between island–mainland distance (x-axis) and the percentage of protected island area (y-axis). The black line represents the global trend; colored lines represent individual countries.

At the country level (Fig. 3), Italy and Greece host the largest extent of protected island areas, followed by France and Cyprus. Only Morocco, Lebanon, Croatia, and France exceed the 30% protection target, while Lebanon, Morocco, and Spain surpass the 10% strict-protection goal.

Among the 1,327 islands with at least one PA, 160 include strictly protected areas, and 88 of these are entirely or almost entirely (≥90%) strictly protected. Although Italy, Spain, and France contain the highest numbers of such islands, Lebanon and Morocco exhibit the highest relative protection (Tab. 1). In Fig. 4 are reported the distributions of this islands in the Mediterranean basin.

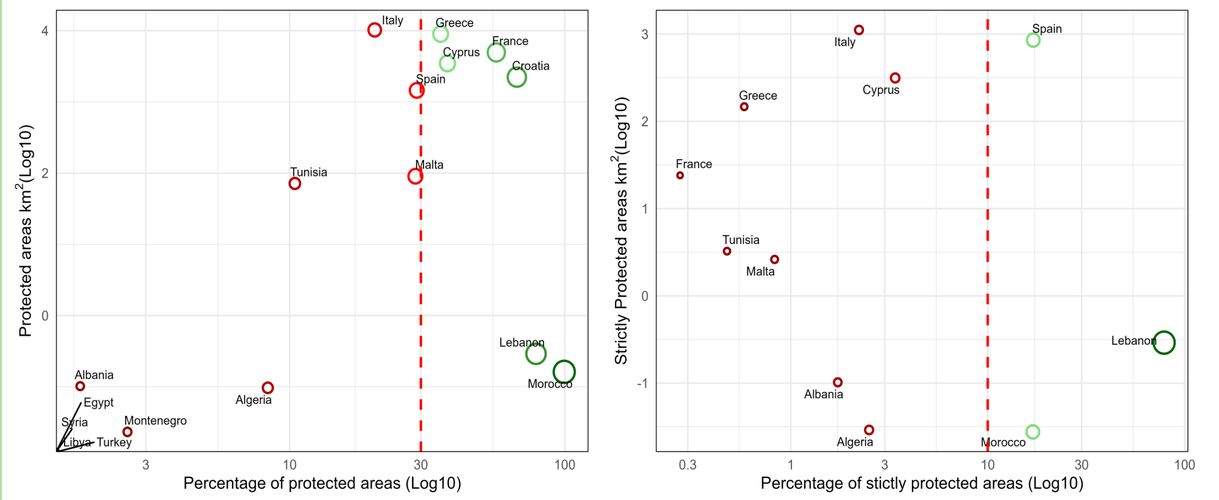


Fig.3: Extent of total (left) and strictly protected (right) island areas (km²) by country vs. the proportion of protected area (%). Red dashed lines indicate the 30% and 10% protection targets set by the Global Biodiversity Framework for 2030.

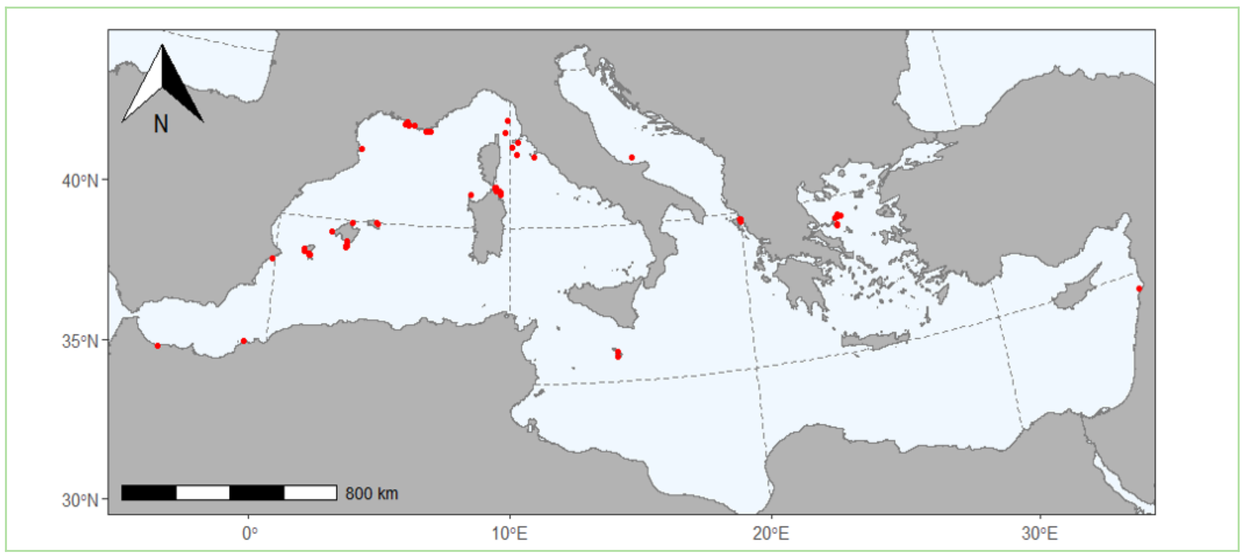


Fig. 4: Map of Mediterranean islands (red points) with ≥ 90% of their surface under strict protection (IUCN categories Ia, Ib, and II).

| Country | Number of island | Total Area (Km²) | Proportion of country island area (%) |
|---|---|---|---|
| Albania | 3 | 0.10 | 1.73 |
| Algeria | 1 | 0.03 | 2.50 |
| France | 14 | 8.90 | 0.10 |
| Greece | 10 | 47.62 | 0.19 |
| Italy | 33 | 131.59 | 0.26 |
| Lebanon | 3 | 0.29 | 78.65 |
| Malta | 2 | 0.10 | 0.03 |
| Morocco | 1 | 0.03 | 16.95 |
| Spain | 21 | 19.91 | 0.40 |
| **Total** | **88** | **208.57** | **0.20** |

Tab. 1: Number, total area (km²), and area proportion of islands under ≥90% strict protection (IUCN Ia, Ib and II), by country.

## Conclusions

The study reveals large disparities in the protection of Mediterranean islands. Despite substantial progress in some countries, most remain below global conservation targets. Small islands show high relative protection, but large islands dominate in total protected area. These findings emphasize the need for more balanced and coordinated conservation strategies in the Mediterranean to effectively achieve the 30×30 and 10×10 goals of the Global Biodiversity Framework.

## References

[1] Médail, Frédéric. 2017. 'The Specific Vulnerability of Plant Biodiversity and Vegetation on Mediterranean Islands in the Face of Global Change'. *Regional Environmental Change* 17 (6): 1775–90. https://doi.org/10.1007/s10113-017-1123-7. [2] Médail, Frédéric. 2021. 'Plant Biogeography and Vegetation Patterns of the Mediterranean Islands'. *The Botanical Review* 88 (1): 63–129. https://doi.org/10.1007/s12229-021-09245-3. [3] Santi, Francesco, Riccardo Testolin, Piero Zannini, et al. 2024. 'MEDIS—A Comprehensive Spatial Database on Mediterranean Islands for Biogeographical and Evolutionary Research'. *Global Ecology and Biogeography* 33 (8): e13855. https://doi.org/10.1111/geb.13855

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